Heterogeneity During the Financial Market Crisis 2007/2008 – Liquidity and Solvency Risks to Different Financial Intermediaries

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Consumer reaction to tumbling funds - Evidence from retail fund outflows during the financial crisis of 2007/2008

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Abstract

Contrary to the findings reported in some of the extant literature, our study indicates that over the past few years a change in investors' behavior patterns means that investment decisions are made at short notice, and that shares are redeemed in a discriminatory manner when funds perform poorly. By using data assembled from 1672 retail funds in Germany over the period March 2008 to April 2010, we are able to show that in general, both the prior fund performance and prior net redemptions have a statistically significant influence on fund outflows. Moreover, there are indications that in recent crises situations that have resulted in the withdrawal of shares investors react fast to market signals.

JEL Classification Numbers: G01, G23, G14, G28, D53

Keywords: Liquidity risk; financial fragility; bank run; mutual funds; fund flows; net redemptions of fund shares; fund performance; fund industry; risk sharing

1. Introduction

This paper intends to expand on the current literature on flows of German retail funds by examining some aspects of shareholders' redemption behavior during the financial market crisis from 2008 to 2010. Our study focuses primarily on the relationship between fund performance and the redemption of shares by investors. Furthermore, we examine whether investor behavior is linked to fund category when shares are being redeemed as a result of disturbances in the financial markets, and whether significant outflows from funds can induce other investors to also redeem their shares *(domino*

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effect). Thus, our considerations try to enlighten the ambiguous streams of scientific literature that have been published so far and might be explained by the fact that during the financial crisis of 2007/2008 the fund industry have reported net outflows for the first time ever.

Ippolito (1992), Sirri and Tufano (1998) and Del Guerico and Tkac (2002) have already proven the general correlation between prior fund performance and net flows, whereas Cashman et al. (2006) have examined investors perseverance in light of outflows from poorly performing funds. Their findings suggest that investors traditionally responded immediately to well performing funds by making additional investments, while at the same time displaying reluctance to redeem shares from poorly performing funds.

Our analysis, however, suggests the opposite, namely, that investors are quick to react to market signals, and will withdraw their investments early in times of crises. We can demonstrate that investor behavior no longer conforms to the perseverance hypothesis of Cashman et al. (2006), but now turns to different market signals in order to try to anticipate the withdrawal tendencies of other investors, which can result in panic redemption of shares by a domino effect. The question arises as to why comparable studies no longer yield comparable results. We would suggest that increasing reliance on the internet for the dissemination of information, and the decreasing associated costs, even private investors could respond rapidly to any information that might indicate strategically complementary dependencies. This, in turn, results in greater market fluctuation, where markets are increasingly driven by demand and supply scenarios.

Although an increasing number of retail clients invest in shares for the purposes of wealth building and retirement security, the relevant markets have received relatively little research attention so far, particularly in relation to liquidity risks and investors' mitigation behavior. In February 2011, the retail fund market in Germany was valued at about € 342.3 trillion. Of these, *equity funds* made up 33.74%, *fixed income funds* 16.26%, *balanced funds* 6.89% and *money market funds* 2.56% of total the market volume. Open *real estate funds* accounted for a further 25.48% (for further details see Capital market statistics of Deutsche Bundesbank [2011]).

A number of publications focus their considerations on specific fund segments, which enables their authors to avoid additional problems posed by potential correlations

occurring between the different fund categories and successive aggregate fund flows emerging as a result of self-fulfilling investors pessimism during times of crisis. Warther (1995), for instance, concentrated specifically on the study of aggregate fund flows, while Edelen and Warner (1999) focused their attentions on the effects of prior performance on the returns of mutual funds.

As pointed out, contemporaneous research, defines the relationship between net flows and fund performance differently.[4] Table 1 illustrates that in the past papers have tended to look for a positive linear correlation (Spitz [1970], Smith [1978], Kane, Santini & Aber [1991], Hendricks, Patel and Zeckhauser [1991], Brown and Götzmann [1995], Gruber [1996], Berk & Green [2002]).

Table 1: Two strands of literature providing the relationship between fund performance fund and flows

general positive relationship between performance & flows	Spitz (1970) Smith (1978) Hendricks, Patel and Zeckhauser (1991) Kane, Santini and Aber (1991) Ippolito (1992) Brown and Götzmann (1995) Gruber (1996) Berk & Green (2002)
non-linear relationship between performance & flows	Sirri and Tuffano (1998) Edelen (1999) Chevalier and Ellison (1995) Del Gueric and Tkac (2002) Bergstresser and Poterba (2002) Goetzmann and Massa (2003) Lynch & Musto (2003) O'Neal (2004) Cashman (2006) Huang et al. (2007) Iskovic and Weissbenner (2009)

In contrast, other research work assumes a non-linear relationship between net flows and prior performance (Chevalier and Ellison [1995], Cashman [2006] or Del Gueric and Tkac [2002]). To be more precise, some papers are suggesting an asymmetric behavior of investors with inflows related to prior performance and outflows that are not

[4] Net flows equal the difference between inflows and outflows of specific funds.

related to prior performance of a fund. Hendricks, Patel and Zeckhauser (1993), for example, found that investors with shares in even the most poorly performing funds generally behaved consistently in not immediately withdrawing their shares. Carhart (1997) has suggested that the withdrawal costs of shares have an important influence on fund returns. Brown and Götzmann (1995) have also observed a correlation between high punitive withdrawal fees, and investor reluctance to redeem their shares even when invested in poorly performing funds, but are unable to offer a reason for this.

Thus, the analytical works on investors' behavior in connection with the redemption of fund shares has led to ambiguous results in the recent literature. For that reason, it appears difficult to construct a theoretical model that explains the redemption behavior of investors in retail funds. In recent research works some attempts are published to establish a theoretical model clarifying investors' behavior especially in poorly performing funds. Nevertheless, these models do not enlighten the whole story which might be due to the fact that in the past the fund industry was steadily growing because aggregated amount of inflows have extended aggregated amount of outflows ever. Sebastian and Tyrell (2006), for instance, established a theoretical model explaining that a run on the shares of any individual fund should not always be seen as a negative; on the contrary, it can have a sanitizing result in that it punishes ineffectual management of retail funds. Within this context, the authors highlight the issue of moral hazard arising in connection with buoyant markets, and take a more critical stand towards regulatory intervention proposed, for example, by Diamond and Dybvig (1983).

In order to enlarge the empirical ground for building a reasonable theoretical model that explains investors' behavior in more detail our paper contributes to the scientific literature the most recent findings from the German fund industry over a period with aggregated outflows from the industry for the first time ever.

Our paper will begin by examining the question whether the perseverance hypothesis as put forward by Cashman et al. still applies to the twenty-first-century investor, or whether their investors' behavior can be shown conclusively to have changed to a pattern that is more responsive to the likely knock-on effects of market fluctuations and their consequences. In general, taking up the assumption made by Sirri and Tufano (1998) that consumers are realizing the likelihood that worst performing funds will continue to perform poorly and that consumers are supposing that well performing funds will continue showing an above average performance in the future we follow the

hypothesis that poorly performing funds will face significant redemptions of shares and that well performing funds will be hit less by withdrawals of fund shares even over a crisis situation in the financial markets.

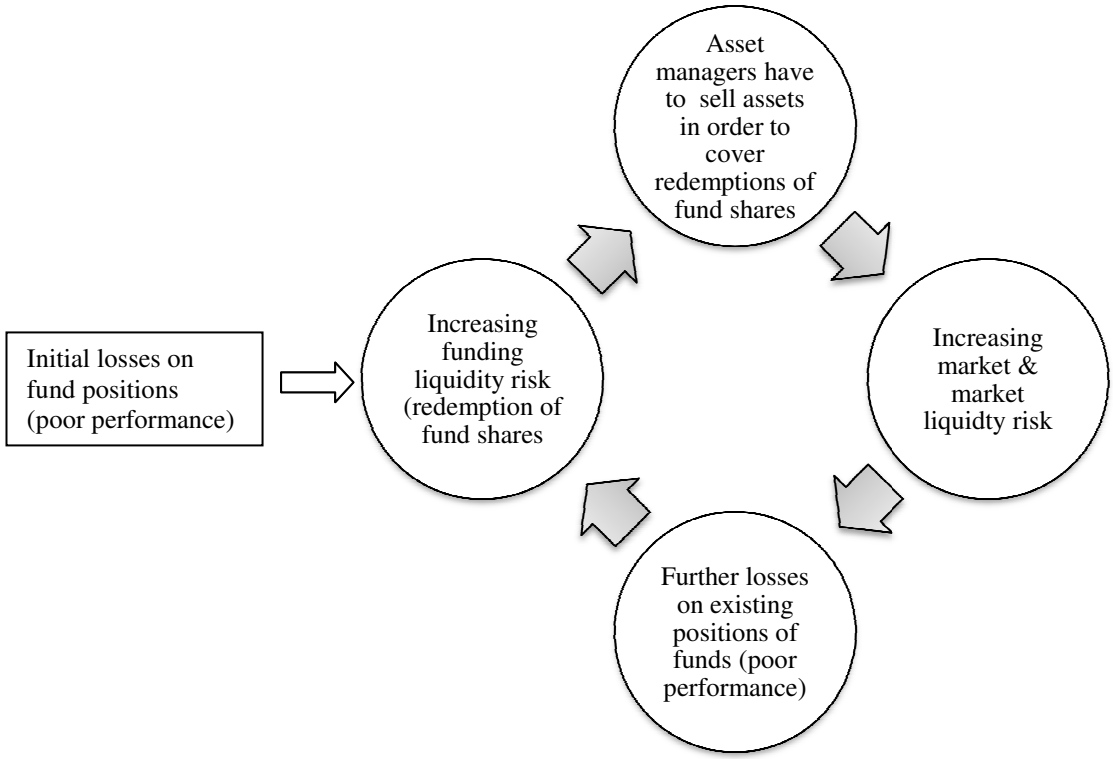
Our findings agree with the observations put forward by both Edelen (1999) and Coval and Stafford (2007), who have shown that fund managers on occasion have to be subjected engage in to cost-intensive and unprofitable trades in order to adapt their portfolios to changing market situations and liquidity requirements. It is of major economic interest that particularly in the event of unexpected outflows, when asset managers are forced to liquidate assets in 'fire-sale-conditions', profits begin to decrease. Because fund managers carry out the majority of cash generating trades on the day after the withdrawal of fund shares, the net asset value (NAV) of a fund will not completely transfer the real costs to the withdrawing investors. On the contrary, the costs of premature liquidation of assets devolve to the more cautious investors who remain in the fund. This may lead to a strategically complementary dependence, because the higher the number of investors withdrawing from a fund, the lower the expectations for future returns, thus increasing the likelihood of more investors withdrawing from the fund, causing a liquidity shortage. The more assets are liquidated, the higher the devolved costs become, increasing the potential losses due to higher liquidation costs for the remaining investors. Particularly, when market conditions are strained is the likelihood greater that investors reject the adjusted market price, making it more costly to sell illiquid assets than under normal circumstances in the financial markets. To illustrate this further our empirical analysis will compare the differences of outflows in conjunction with fund categories and prior performance. In doing so, we aim to contribute towards an improved understanding of investors' behavior in crisis situations.

While on the whole the scientific literature so far has focused on the US markets, our study will be concentrated on examining investor behavior in the German fund markets.[5] The study is made more interesting in that the 2007/2008 crisis represents the first occasion on which the German fund industry was confronted with significant aggregate outflows from funds (see Capital market statistics of Deutsche Bundesbank [2011]). Despite the uniqueness of this phenomenon, or perhaps because of it, it has not

[5] Tkac (2004) gives a general overview on American fund market and discuss regulatory methods and consequences for the fund industry.

been the subject of academic study so far, although Bannier, Fecht and Tyrell (2006) and Ber et al. (2011) have published some papers examining aspects of the German fund market. Considering the fundamental influence of crises on the economic power of individual countries, it is important to understand the consequences of such fluctuations. Brunnermeier (2010) have established a model that could explain the detoriations in the financial markets by a self-amplifying spiral covering market and funding liquidity risks of bank positions. This model also seems to be appropriate for the fund industry because a retail fund is also faced funding liquidity and market liquidity risks to a different degree that is depending on the examined fund category.

Figure 1: Self-amplifying effects between market and funding liquidity risks of retail funds



For this reason, our investigation into investors' behavior and their decision-making processes is based upon data gathered from a number of German retail fund. In other words, we will prove two hypotheses.

- Hypothesis 1: There is a correlation between fund outflows and the corresponding fund category.

- Hypothesis 2: Fund outflows relate to prior performance and prior redemption of fund shares.

Our paper will proceed by giving an outline description of the date used for this study in Section 2. In Section 3 we introduce some descriptive statistics on the evolution of net flows in specific fund markets, while Section 4 presents the findings of our analyses in support of our hypotheses. Our paper concludes with a summary of our conclusions, together with our recommendations, based upon our findings, of how the industry might guard against similar sudden fund fluctuations in the future.

2. Data

The data assembled for these analyses consist of 35,895 monthly observations from 1,672 German retail funds, as reported to the *Deutsche Bundesbank* by the German asset management companies between March 2008 and April 2010.[6] German asset management companies report the related fund categories, net asset values, and monthly flows of funds to Deutsche Bundesbank. These comprise of 695 *equity funds*, 367 *fixed income funds*, 540 *balanced funds*, 58 *money market funds*, 11 *mortgage funds* and 17 *convertible funds*. We have eliminated from our sample all those funds, which have closed or merged with other retail funds during our observation period to avoid fund flows in our sample that are solely driven by the process of merging and closing a fund. For the same reason, we have also excluded all those funds from our sample that reported a net asset value of less than € 1,000,000.

One objective of our study is to test the dependencies between monthly net redemptions of fund shares and prior performance of funds, whereby the monthly net redemptions of fund *j* with NAV (Net Asset Value) at month *i* are calculated with the equation

$$net\ redemptions_{ij} = \frac{inflows_{ij} - outflows_{ij}}{NAV_{i-1,j}}.$$

The monthly performance of fund *j* with NAV (Net Asset Value) at month *i* is calculated as follows:

$$performance_{ij} = 1 - \left(\frac{NAV_{i,j} - net\ redemptions_{ij}}{NAV_{i-1,j} - net\ redemptions_{i-1,j}}\right). \quad .$$

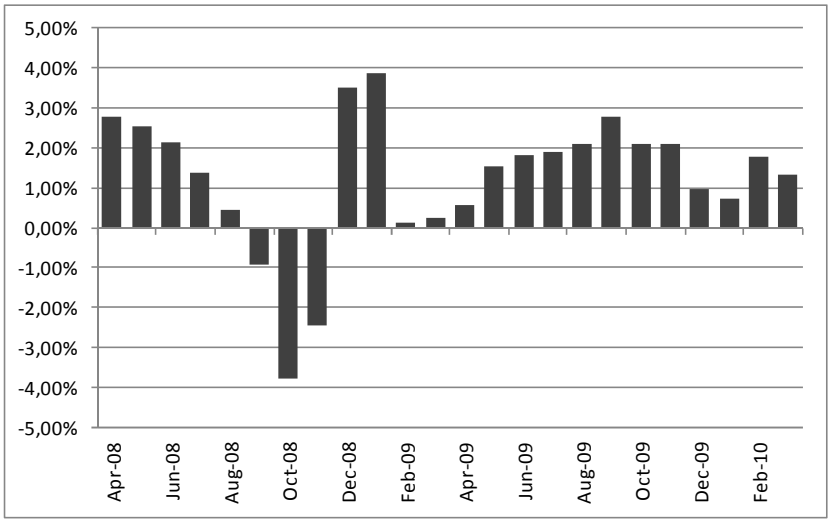
[6] We thank the German Association of Investment and Asset Management (BVI) for their friendly supporting this data issue.

Furthermore, we have conducted several statistic assessments of the structure and dynamics of fund flows from 2008 to 2010 with a primary focus on net redemptions during the financial crisis in 2007/2008. The next section will also show the calculations to test for correlations between the various independent variables described in Table 4, and the net redemption of fund shares, using several ordinary least square regressions.

3. Descriptive Statistics

During the financial market turmoil of 2007/2008, the German fund industry was experiencing its most extreme outflows from retail funds in more than three decades (BVI Jahrbücher [1999–2010]). Not surprisingly, our sample, which includes 6 different categories of retail funds, shows an unprecedented number of redemptions of fund shares between September and November 2008. The crisis reached a preliminary height with the collapse of Lehman Brothers in September 2008, and a peak net outflow of 3.77% in October 2008. After this, the fund industry recovered sufficiently to record renewed investor confidence in the funds market during 2009.

Figure 2: Percentage of averaged two-month net redemptions from 2008 to 2010



As well as showing the average monthly fund flows, Table 2 shows the monthly percentage of funds characterized by two-month net outflows thus outflows are higher than inflows over a two-month period. We have selected the two-month horizon of net redemptions in order to avoid the possibility of the inflows and outflows from two consecutive months balancing each other out. Despite the surprisingly high percentage of funds reporting two-month net outflows over the entire observation period, a peak of this phenomenon is discernible in September 2008, coinciding with the peak of the

financial crisis. This is followed by the lowest number of funds reporting two-month net outflows, which falls below the 40% mark between May and September 2009. The relatively high proportion of funds reporting two-month net outflows over the entire observation period can, however, be explained by cross-sectional fund flows from one fund to another.

A more detailed view on the various fund categories covered by our sample suggests that the manner in which investors might react in crisis circumstances may be fund-specific, i.e. that investors in the same type of fund will also be likely to display similar behavior or decision-making patterns.

Table 2: Two-month net redemptions grouped by month of observation period
Our sample contains 35,895 monthly observations from 1,672 funds from March 2008 to April 2010. Among the 1,672 funds appear 695 equity funds, 367 fixed income funds, 540 balanced funds, 58 money market funds, 11 mortgage funds and 17 convertible funds. Balanced funds are invested in equities and fixed income securities. Per definition, convertible funds are funds that invest in convertible bonds. The monthly net redemptions equal the difference of inflows into funds and outflows from funds. The two-month net redemptions equal the sum of net redemption in two consecutive months. We calculate the percentage of funds with outflows is as the ratio of the number of funds with negative two-month net redemptions (outflows) to the total number of funds.

Month	Averaged two-month net redemptions	Percentage of funds with outflows	Month	Averaged two-month net redemptions	Percentage of funds with outflows
01.04.2008	2.78%	45.17%	01.04.2009	0.56%	43.32%
01.05.2008	2.53%	46.65%	01.05.2009	1.53%	38.19%
01.06.2008	2.14%	50.08%	01.06.2009	1.81%	35.99%
01.07.2008	1.38%	48.13%	01.07.2009	1.89%	37.25%
01.08.2008	0.43%	54.45%	01.08.2009	2.11%	35.17%
01.09.2008	-0.91%	63.85%	01.09.2009	2.79%	35.29%
01.10.2008	-3.77%	59.97%	01.10.2009	2.09%	38.95%
01.11.2008	-2.47%	45.39%	01.11.2009	2.10%	39.79%
01.12.2008	3.49%	42.34%	01.12.2009	0.97%	42.05%
01.01.2009	3.85%	46.61%	01.01.2010	0.72%	43.79%
01.02.2009	0.12%	45.49%	01.02.2010	1.76%	41.28%
01.03.2009	0.23%	46.66%	01.03.2010	1.33%	43.12%

Table 3 demonstrates *money market funds*, *fixed income funds* and funds invested in convertible bonds *(convertible funds)* are faced with the highest net redemption of fund shares that with respect to their median of outflows. Furthermore, the highest percentage of funds reporting two-month net outflows also fall into the same fund categories. From the viewpoint of industry it is important to know whether funds are liquid enough to cover redemptions of fund shares by investors because otherwise fund managers have to sell assets of funds that face extraordinarily outflows under tensioned market circumstances. Brunnermeier (2010), and Adrian and Shin (2010) have already

established the fundamental risk to market liquidity that such *'fire sales'* represent. For that reason, we approximate the 99th percentiles of two-month net redemptions calculated based on estimated extreme value distributions. Table 3 shows only slight differences of approximated 99th percentiles between *equity funds*, *mortgage and convertible funds* and *fixed income funds*.[7] This calculation indicates that the funds experiencing the highest risk of redemption from 2008 to 2010 were the *money market funds*. By contrast, *balanced funds*, i.e. funds whose portfolios are made up of both equities and fixed income securities, evidence much less risk of redemptions than the categories of funds discussed above. The relatively low redemption risk observed in the case of *balanced funds* can be explained through the lower losses this fund category reported during financial market crisis episodes.

As stated previously, the great majority of funds recorded massive losses during the 2008 crisis because of the collapse of the global asset markets. Estimated 99th percentiles of funds` losses reported in Table 3 are significantly higher at *equity funds* than those of *fixed income funds*, which might be due to more volatile equity markets.

To illustrate the correlation between the redemption of fund shares and extraordinarily high losses under crisis circumstances we have also calculated the susceptibility of investors to poor performance of funds. This has been achieved by comparing the ratio between 99th percentile of losses and 99th percentile of two-month net redemptions. In doing so, we have made a distinction between *outperforming funds* and *underperforming funds*. By definition, *outperforming funds* report a higher net asset value (NAV) at the end of each observed month due to a positive performance accrual from the beginning of the observation period in March 2008 while *underperforming funds* demonstrate a decreasing net asset value (NAV) at the end of each observed month due to a negative performance accrual. In order to measure the consistency of fund performance, and net redemptions we have set the standardized performance indicator *'perfind'* over the respective observation period $n=1,\ldots,n$ recursively to assess the prior performance with the beginning of our observation period set *'perfind'* at 100 to represent fund performance up to observation period to create benchmark against which to calculate fluctuations 2007/2008:

[7] Approaches emanating from Extreme-Value-Theory allow the reliable prediction of the likelihood of rare but also plausible events since they model the 'fat tails' of empirical distributions with sufficient accuracy. In such a way, they can also assess the daily net redemptions of funds and the fund performance from empirical data even in times of a crisis (Reiss R.–D. and Thomas M. [2000], Longin [2000], Embrechts, Klüppelberg, Mikosch [1997]). For the estimation of parameters we rely on a genetic algorithm that delivers reliable and valid results for our purposes.

$$perfind_0 = 100$$
$$perfind_1 = perfind_0 + (performance_{1j} * perfind_0)$$
$$\vdots \qquad\qquad \vdots$$
$$perfind_{n-1} = perfind_{n-2} + (performance_{n-1,j} * perfind_{0,n-2})$$
$$perfind_n = perfind_{n-1} + (performance_{nj} * perfind_0).$$

The following simple example may clarify the calculation of the performance indicator *'perfind'*:

	outperforming funds		**underperforming funds**	
month	monthly performance	performance indicator	monthly performance	performance indicator
0	0.00%	**100.00**	0.00%	**100.00**
1	1.00%	100.00 + 1.00% * 100.00 = **101.00**	-1.00%	100.00 - 1.00% * 100.00 = **99.00**
2	1.40%	101.00 + 1.40% * 101.00 = **102.41**	-1.40%	99.00 - 1.40% * 99.00 = **97.61**
3	-0.05%	102.41 - 0.05% * 102.41 = **102.36**	-0.05%	97.61 - 0.05% * 97.61 = **97.57**
4	-0.56%	102.36 - 0.56% * 102.36 = **101.79**	0.56%	97.57+ 0.56% * 97.57= **98.11**

In other words, by definition *outperforming funds* report a performance indicator *'perfind'* that is greater than 100 while *underperforming funds* are providing a performance indicator *'perfind'* that is below 100.

In order to measure the consistency of prior net redemptions of a fund we also calculate the standardized net redemption indicator *'nma_ind'* over the respective observation period $n = 1, \dots, n$ recursively:

$$nmaind_0 = 100$$
$$namind_1 = nmaind_0 + (net\ redemptions_{1j} * nmaind_0)$$
$$\vdots \qquad\qquad \vdots$$
$$namind_{n-1} = nmaind_{n-2} + (net\ redemptions_{n-1,j} * nmaind_{n-2})$$
$$namind_n = nmaind_{n-1} + (net\ redemptions_{nj} * nmaind_{n-1}).$$

Table 3 shows that the underlying susceptibilities of *outperforming funds* are clearly greater than the susceptibilities of *underperforming funds* in general, whereas *money market funds* and *fixed income funds* provide the highest values of our sensitivity

assessment. At the same time, the sensitivity assessment suggests that shareholders in *equity funds* and *balanced funds* display the least susceptibility. This suggests that investors in *money market funds* and *fixed income funds* respond more dramatically than investors with *equity funds* or *balanced funds*. This observation is likely to be based in the fact that, historically, *fixed income funds* and *money market funds* were promoted by the fund industry as the more appropriate investments for risk-adverse investors.

In summary, our descriptive statistics do provide some evidence that based upon fund flows, *balanced funds* can be declared the 'winners' for the duration of the observation period, and reflects the relatively low risk exposure associated with this fund category. By contrast, *money market funds* are faced with surprisingly sharp increases in redemptions during a period of increasing yields in the money market instruments.

Table 3: Two-month net redemptions grouped by categories of funds
We calculate the percentage of funds with outflows as the ratio of the number of funds with negative two-month net redemptions (outflows) to the total number of observations. (n = number of observations, average and median are calculated over the entire period in question from 2008 to 2010). Sensitivity equals the ratio between 99th percentiles of losses and 99th percentiles of two-month net redemptions. 99th percentiles are calculated based on approximated extreme value distributions (GEV or GPD).[8]

	Equity Funds	Money Market Funds	Mortgage Funds
n	14,768 / 7,677	1,427 / 983	284 / 103
% observations with outflows	51.98%	68.89%	36.27%
Average / median of outflows	-0.11% / 0.90%	-5.82% / -4.27%	-1.49% / 0.11%
99th percentile net redemptions	34.98%	31.04%	31.81%
99th percentile losses	53.02%	29.79%	43.22%
Sensitivity (entire sample)	0.66	0.90	0.74
Sensitivity (outperforming funds)	1.16	1.49	1.65
Sensitivity (underperforming funds)	0.64	0.86	0.74
	Balanced Funds	Fixed Income Funds	Convertible Funds
n	10,536 / 4,318	7,990 / 4,719	394 / 251
% observations with outflows	40.98%	59.06%	63.71%
Average / median of outflows	3.62% / 0.00%	0.45% / -0.93%	-2.24% / -2.12%
99th percentile net redemptions	18.55%	31.04%	31.81%
99th percentile losses	29.79%	34.16%	43.22%
Sensitivity (entire sample)	0.62	0.91	0.74
Sensitivity (outperforming funds)	0.78	1.17	1.65
Sensitivity (underperforming funds)	0.62	0.85	0.74

[8] GEV (Generalized Extreme Value Distribution), GPD (Generalized Pareto Distribution)

4. Analytics and Results

In order to test our hypothesis that poor fund performance is punished by substantial redemptions of fund shares due to shrinking investor confidence in the fund industry, and that those outflows subsequently lead the *domino effect* that is created by these withdrawals, we have examined a number of regression models. We have used these regressions to test our hypothesis that investors do show a distinguishable redemption behavior throughout our sample period, and that a correlation exists between investor reaction and the category of fund invested in. For a more detailed view, we have tested a number of performance indicators, measures of prior redemption of fund shares and financial market indicators as control variables for their relevance to the independent variable *'net redemptions'*. This variable reflects the percentiles of two-month net redemptions of fund shares that we estimate by appropriate extreme value distributions. We have selected this approximation model to enable us to focus our investigations on extreme outflows only, because of the asymmetric distribution of fund withdrawals during crisis periods. For that reason Cashman et al. (2006), for instance, examine whether different quantiles of prior performance show distinguishable relations with net outflows from funds.

Table 4: Dependent and independent variables

Variable	Definition	Calculation formula/Source
net redemptions (dependent variable)	Percentiles of two month net redemption of fund shares approximated by fitting extreme value distributions[9]	$nma2m_{ij} = \left(\frac{inflows_{ij} - outflows_{ij} + inflows_{i-1,j} - outflows_{i-1,j}}{NAV_{i-2,j}}\right)$ $net\ redemptions = evtnma2m = percentile_{GEV,GPD}(nma2m_{ij})$
prior performance (indexed)	Standardized performance indicator (calculated recursively)	$perfind_0 = 100$ $perfind_1 = perfind_0 + (performance_{1j} * perfind_0)$ $\vdots \quad \vdots \quad \vdots$ $perfind_n = perfind_{n-1} + (performance_{nj} * perfind_0)$
prior redemptions (indexed)	Standardized net redemptions indicator (calculated recursively)	$nmaind_0 = 100$ $namind_1 = nmaind_0 + (net\ redemptions_{1j} * nmaind_0)$ $\vdots \quad \vdots \quad \vdots$ $namind_n = nmaind_{n-1} + (net\ redemptions_{nj} * nmaind_{n-1})$

[9] Approaches emanating from Extreme-Value-Theory allow the reliable prediction of the likelihood of rare, but also plausible events since they model the 'fat tails' of empirical distributions with sufficient accuracy. (Reiss R.–D. and Thomas M. [2000], Embrechts [2000], Embrechts, Klüppelberg, Mikosch [1997]). For the estimation of parameters we relied on a genetic algorithm which delivered reliable and valid results for our purposes.

Table 4: Dependent and independent variables (continued)

Variable	Definition	Calculation formula/Source
log10 performance	Logarithm to base 10 of standardized performance indicator	$log10\ performance = log10(past\ performance)$
log10 redemptions	Logarithm to base 10 of standardized performance indicator	$log10\ redemptions = log10(nma\_ind)$
performance	Percentiles of monthly performance approximated by fitting extreme value distributions	$perf_{ij} = 1 - \left(\frac{NAV_{i,j} - net\ redemptions_{ij}}{NAV_{i-1,j} - net\ redemptions_{i-1,j}}\right)$ $performance = evtperf = percentile_{GEV,GPD}(performance_{ij})$
two month performance	Percentiles of two months performance attribution	$per2m_{ij} = 1 - \left(\frac{NAV_{i,j} - net\ redemptions_{ij} - net\ redemptions_{i-1,j}}{NAV_{i-2,j} - net\ redemptions_{i-2,j}}\right)$ $\text{two month performance} = evtperf2m = percentile_{GEV,GPD}\left(per2m_{ij}\right)$
msci	Monthly percentage change of MSCI World	extracted from Bloomberg[10]
vola	Monthly volatility of MSCI World	extracted from Bloomberg
gbi	Monthly percentage change of JPM Global Bond Index	extracted from Bloomberg
gold	Monthly percentage change of gold price	extracted from Bloomberg
libor	Monthly libor rate	extracted from Bloomberg

A. Hypothesis 1: There is a correlation between fund outflows and the corresponding fund category

As stated before, one objective of our study is to confirm our hypothesis that a correlation exists between net fund outflows, and their corresponding fund category. Therefore, we have used fund classifications as a factored predictor-variable with fixed effects to our panel regression. Table 5 shows that apart from *convertible funds* and underperforming *mortgage funds*, the fund classification variable illustrates a significant negative correlation with the dependent variable for all fund categories but to a different extent, whereas the classifier for *equity funds* is the basis of our factored variable. *Money market funds* and *convertible funds*, however, show markedly lower coefficients than those in the other fund categories. This observation corresponds to the findings

[10] Bloomberg PLC is one of the leading providers of financial market information.

displayed in Table 3, which shows that *money market funds* and *convertible funds* experienced the highest rate of two-month share redemptions. In addition, the results indicate that investors do distinguish between *outperforming funds* and *underperforming funds* because the fund categories enter our regression with higher coefficients for *outperforming funds* than those for *underperforming funds*. In this context it should be noted that the higher intercept of *outperforming funds* in comparison to *underperforming funds* reflect the distinguishable net flows of these two subsamples. Thus, these findings are also consistent with the sensitivity measures illustrated in Table 3. Taking into account that in Table 3 the related fund categories show significant performance differences over the observation period, these differences between *outperforming funds* and *underperforming funds* also highlight that the prior performance of a fund is one of the driving forces for the redemption of fund shares by investors.

B. Hypothesis 2: Fund outflows relate to prior performance and prior redemption of fund shares

In the case of the performance variables *'two month performance'* and *'performance',* we also rely on the estimation of percentiles of the empirical performance distributions by the means of extreme-value-distributions. For better orientation, we emphasize at this point that the higher the percentiles of the respective two-month net redemptions the more investors appear to redeem fund shares. Table 5 reports positive and statistically significant coefficients for the performance variables *'two month performance'*, *'performance'* and *'log10 performance'* that reflect the corresponding percentiles of the performance over the prior two months, percentiles of the prior monthly performance and our standardized prior performance indicator, respectively. From this we can conclude that the best performing funds are those which show higher inflows. By contrast, our flow indicator *'log10 redemptions'* exhibits a positive effect on the two-month net redemptions since it achieves a negative and statistically significant coefficient. The calculations prove that increased outflows from funds do induce further redemptions of shares by investors.

To summarize this far, it can be said that both performance variables and flow variables display a significant influence on the two-month net flows of fund shares. Particularly the examined fixed effects regressions also suggest that the redemption of

fund shares by investors in any one period usually has an impact on the flows of funds in the period following. The different intercepts observed in *outperforming funds* and *underperforming funds* support these findings further. Since the indicators for the persistence of prior net redemptions result in negative and statistically significant coefficients, the regression models indicate that a significant number of investors redeem their shares because they have become aware of other investors having done so. As consumers typically do not receive any information on investment flows of funds in detail, we would suggest that this type of investor behavior must be the result of negative media reports circulating about the fund industry at the time.

In addition, we have applied financial market indicators as control variables to examine if net flows of funds reflect movements of the financial markets. Among the control variables, our indicators on the performance in global stock markets *('msci')* and stock market uncertainty *('vola')* prices generate positive and statistically significant coefficients, suggesting that the returns in the global stock markets can induce further flows of funds. By contrast, however, Table 5 displays a negative and statistically significant correlation between the dependent variable and the indicator on global bond market prices *'gbi'*. In that instance, both the *'libor'* rate and our variable *'gold'* show only a weak influence on the flows of funds.

Table 5: Panel regression with fixed effects

This table shows the results of a panel regression with fixed effects. The percentiles of two-month net redemptions of fund shares are the dependent variable. The factor variable for the fund categories relates to equity funds as the base level. The sample covers the two-month net redemptions of 33,739 observations and 1,648 funds respectively over the period March 2008 to April 2010. In the event of outperforming funds, the sample covers the two-month net redemptions for 13,663 observations and 1,047 funds. In the case of underperforming funds, the sample covers the two-month net redemptions for 20,076 observations and 1,110 funds. The outperforming funds report a higher net asset value (NAV) at the end of the observed month due to a positive performance attribution from the beginning of the observation period in March 2008. In contrast, the underperforming funds illustrate a lower net asset value (NAV) at the end of the observed month due to a negative performance attribution (since the beginning of the observation period in 2008). Significance levels are marked with *** (P>t) <=0.01, ** (P>t) <=0.02 and * (P>t) <=0.05.

	Fixed (time) effects regression			Fixed (within) effects regression		
	All funds	Outperf. Funds	Underperf. Funds	All funds	Outperf. Funds	Underperf. Funds
	Coef. (Std. Err.)	Coef. (Std. Err.)	Coef. (Std. Err.)	Coef. (Std. Err.)	Coef. (Std. Err.)	Coef. (Std. Err.)
two month performance	0.18*** (0.006)	0.174*** (0.010)	0.154*** (0.008)	0.503*** (0.048)	0.433*** (0.062)	0.316*** (0.064)
performance	0.47*** (0.006)	0.540*** (0.010)	0.407*** (0.007)	0.506*** (0.050)	0.488*** (0.061)	0.491*** (0.065)
log10 performance	0.51*** (0.011)	0.583*** (0.021)	0.465*** (0.016)	0.065*** (0.011)	0.048** (0.020)	-0.015 (0.025)
log10 redemptions	-0.61*** (0.013)	-0.691*** (0.021)	-0.605*** (0.017)	-0.105*** (0.012)	-0.132*** (0.020)	-0.164*** (0.023)
msci	0.74*** (0.024)	0.471*** (0.040)	0.828*** (0.030)	1.078*** (0.337)	0.838*** (0.278)	1.904*** (0.254)
vola	1.69*** (0.085)	1.099*** (0.147)	1.913*** (0.101)	2.136*** (0.636)	1.902*** (0.680)	0.969 (0.545)
gbi	-1.24*** (0.053)	-0.835*** (0.090)	-1.352*** (0.064)	-1.150 (0.737)	-4.093*** (0.698)	-3.832*** (0.530)
gold	0.05*** (0.019)	0.064* (0.032)	0.026 (0.022)	0.446 (0.341)	-0.211 (0.273)	1.026*** (0.196)
libor	-0.01*** (0.001)	-0.024*** (0.002)	-0.002* (0.001)	0.007 (0.008)	-0.008 (0.006)	0.003*** (0.006)
money market funds	-	-	-	-0.031*** (0.009)	-0.106 (0.040)	-0.047*** (0.015)
mortgage funds	-	-	-	-0.086*** (0.020)	-0.058*** (0.009)	-0.057 (0.032)
balanced funds	-	-	-	-0.034*** (0.005)	-0.052*** (0.011)	-0.029*** (0.008)
fixed income funds	-	-	-	-0.030*** (0.005)	-0.006*** (0.035)	-0.019*** (0.008)
convertible funds	-	-	-	-0.014 (0.016)	-0.006 (0.035)	0.008 (0.025)
Intercept	0.46*** (0.016)	0.396*** (0.033)	0.605*** (0.023)	0.074* (0.033)	0.299*** (0.039)	0.467*** (0.045)
R-squared (within between overall)	0.4738 0.5945 0.4948	0.5392 0.4610 0.5012	0.4204 0.4902 0.4256	0.4164 0.8812 0.5287	0.4540 0.7062 0.5282	0.3359 0.6769 0.3955

As a robustness test, we have calculated the variance inflation factors listed in Table 6 to ensure that there are no correlations between our depending variables (for further information on Variance Inflation Factors see Belsley et al. [1980]).

Table 6: Variance Inflation Factors (VIF) of independent variables
This table reports the Variance Inflation Factors (VIF) that we have calculated in order to test the dependent variables on collinearities. The Variance Inflation Factors have an intuitive interpretation. Variance Inflation Factors less than 5 indicates that the independent variable shows only weak multicollinearity (for further information on Variance Inflation Factors see Belsley et al. [1980]).

Variable	VIF	1/VIF
two month performance	3.56	0.2807
performance	3.52	0.2839
log10 performance	5.69	0.1757
log10 redemptions	5.54	0.1804
msci	2.87	0.3480
vola	2.28	0.4382
gbi	1.70	0.5891
gold	1.26	0.7960
libor	1.61	0.6194
Money market funds	1.08	0.9251
Mortgage funds	1.02	0.9837
Balanced funds	1.36	0.7339
Fixed income funds	1.30	0.7720
Convertible funds	1.02	0.9803
Mean VIF	2.37	

Although thus far our regression models have been unable to prove conclusively that poor performing funds are punished by redemptions of fund shares, we can state that both the consistency of prior performance of funds, and the fund categories can exert influence on the two-month net redemptions. The reason that we find only weak support for our hypothesis may be a result of our so far relatively rough distinction between *outperforming* and *underperforming funds*.

To clarify we have performed further tests involving three single ordinary least squares regressions to establish the relationship between *equity funds*, *fixed income funds* and *money market funds* in the context of net redemptions of fund shares.

The results reported in Table 7 illustrate that most of our independent variables significantly relate to the percentiles of two-month net redemptions. The corresponding standardized beta coefficients indicate a strong positive and statistically significant influence on net redemptions by the prior performance of funds *('two month performance'* and *'performance')* for all subsamples. Furthermore, the standardized beta coefficients indicate a strong correlation between our logarithmic net redemption indicator *('log10 redemptions')* and the percentiles of two-month net redemptions for all

different fund categories since it enters the regressions with negative and statistically significant coefficients. This then would suggest conclusively that funds with high prior outflows or funds that report poor performance also experience significant further redemptions of fund shares by their investors. Moreover, we can characterize our control variables by relatively low standard beta coefficients. Only the indicator of the global stock markets (*'msci'*) and the indicator of the global bond markets (*'gbi'*) show a statistical influence on the two-month net redemptions in the case of *equity funds*.

Table 7: Ordinary least squares (OLS) regressions for different fund categories
This table shows the results of an ordinary least square (OLS) regression of independent variables listed in Table 3 on percentiles of two-month net redemptions of fund shares. In addition to coefficients and standard errors, the table displays the standardized beta coefficients. The sample covers the two-month net redemptions for 13,848 observations of equity funds, 7,726 observations of fixed income funds, and 1,373 observations of money market funds over the period March 2008 to April 2010. Significance levels are marked with *** (P>t) <=0.01, ** (P>t) <=0.02 and * (P>t) <=0.05.

	Equity Funds		Fixed Income Funds		Money Market Funds	
	Coef. (Std. Err.)	Beta	Coef. (Std. Err.)	Beta	Coef. (Std. Err.)	Beta
two month performance	0.1966*** (0.0098)	0.2223	0.1888*** (0.0122)	0.1785	0.1434*** (0.0278)	0.1388
performance	0.3965*** (0.0098)	0.4510	0.6867*** (0.0122)	0.6358	0.7698*** (0.0282)	0.7264
log10 performance	0.0766*** (0.0096)	0.0913	0.2812*** (0.0160)	0.3409	0.1174*** (0.0254)	0.1324
log10 redemptions	-0.2754*** (0.0113)	-0.2704	-0.3621*** (0.0166)	-0.4317	-0.1460*** (0.0249)	-0.1674
msci	1.0029*** (0.0475)	0.2317	0.0459 (0.0406)	0.0103	-0.1133 (0.1035)	-0.0237
vola	1.3619*** (0.1572)	0.0810	0.9129*** (0.1460)	0.0521	0.8191* (0.3728)	0.0432
gbi	-1.8474*** (0.1004)	-0.1503	-0.3335*** (0.0909)	-0.0265	-0.6228** (0.2473)	-0.0427
gold	0.1128*** (0.0349)	0.0224	-0.0688* (0.0329)	-0.0132	-0.1489 (0.0838)	-0.0261
libor	-0.0112*** (0.0014)	-0.0644	-0.0025* (0.0012)	-0.0144	-0.0020 (0.0034)	-0.0105
cds	-0.0005*** (0.0001)	-0.0442	-0.0001 (0.0001)	-0.0115	-0.0004 (0.0002	-0.0299
Intercept	0.7143*** (0.0168)		0.2620*** (0.0152)		0.1731*** (0.0335)	
Adj R-squared	0.4358		0.7440		0.7556	

The results from these linear regressions on *equity funds*, *fixed income funds* and *money market funds* are consistent with our hypothesis that the prior performance of funds is strongly related to the two-month net redemptions. Our observations of investors' behavior in such a short term refutes the conclusion put forward in Sirri and Tufano (1992), that consumers abstain from redeeming fund shares when faced with poor performing funds. Regardless of whether net redemptions are caused by sales activities

of the asset management companies or whether they are based on the investors´ reaction to information about prior performance of funds, it seems likely that investors are no longer inclined to take the long-term view with regard to poorly performing funds. Quite the opposite, investors now appear more pro-active about gathering information relating to funds performance, and increasingly ready to discard shares of those funds that show evidence of falling below their level of expectation. In this context, it is worth remembering that the dissemination of fund information via the electronic media has reduced the cost of accessing that information, while at the same time facilitating greater customer awareness of market movements (see for example Bogan [2008]).

In order to test the observed correlation between prior performance of funds and the net redemptions of fund shares, we also intend to examine the ordinary least squares regressions for each quintile of the two-month fund performance. In addition, using the same regression models, we also intend to examine the significance of the relevant fund category on two-month net redemptions. At this point, one should keep in mind that the highest quintiles of this performance measurement represent well performing funds.

Table 8 illustrates that our variables indicating fund performance *('two month performance', 'performance', 'log10 performance')* do indicate a positive and statistically significant relationship with the different quantiles of the two-month net flows of funds. The monthly performance attributions as well as the two-month performance attribution appear to show less influence on the two-month net flows in the higher quantiles of two-month net flows. This indicates that well performing funds are attracting more investments than poor performing funds. Conversely, the results also imply that investors punish poor performing funds by redeeming their fund shares, thereby lending support to our hypothesis. Particularly, we can argue that the standardized performance indicator *('log10 performance'),* which reflects the persistence of fund performance, shows increasing influence on the high quantiles of two-month net flows. This observation is consistent with the standardized indicator of net flows *('log10 redemptions')*, which displays the persistence of net flows during our observation period, but in the opposite direction. Thus, it seems likely that a persistence of net outflows induces further outflows from funds while the persistence of net inflows is highly correlated to further inflows.

Among our control variables the indicator of the global stock markets *('msci'),* the volatility of global stock markets *('vola')* reflecting the uncertainty of participants in the

stock markets and the indicator of the global bond markets *('gbi')* show a statistically significant influence on the two-month net flows of funds. Interestingly, Table 8 reports an increasing influence of these variables within the high quantiles of two-month net flows. This seems to indicate that funds report increasing outflows during periods of high market fluctuations. We would suggest that the opposite sign of the coefficients attained for the indicator of the global stock markets *('msci')* compared with the coefficients provided for the indicator of the global bond markets *('gbi')* echoes the negative correlation between stock and bond markets. In addition, we note that the *gold* prices and *libor rates* show only a weak influence on the two-month net flows of funds.

The results given in Table 8 suggest the observed correlations between our independent variables and the two-month net flows of funds to be consistent with the results provided in Table 7 and Table 5 gained by examining regressions for different sub-samples, such as the different fund categories or *outperforming funds* and *underperforming funds*. The results across different quantiles of the two-month net outflows show similar consistencies. Thus, we can conclude at this stage of our studies that the persistency of fund flows, the persistency of fund performance, as well as the performance of a fund in the short term, can all be expressed in relation to the two-month net flows of funds, particularly in the case of outflows from funds. Therefore, our results are consistent with the findings by Cashman et al. (2006) such that they observe high outflows both of well and poorly performing funds, where a similar shape of curve of fund inflows has been observed, particularly in relation to poorly performing funds. On the understanding that consumers under strained market conditions in light of a declining fund industry generally reduce inflows of new money, we can explain our results more easily by the behavior of investors in more panicked conditions.

Table 8: Simultaneous quantile regressions on the two-month net flows from funds
This table displays the results of simultaneous quantile regressions of our independent variables listed in Table 3 on the percentiles of two-month net redemptions of fund shares. We choose the 20%, 40%, 60% and 80% quantiles and use 10 (bootstrapped) standard error estimations. The sample covers the two-month net redemptions of the entire sample over the period from March 2008 to April 2010. Significance levels are marked with *** (P>t) <=0.01, ** (P>t) <=0.02 and * (P>t) <=0.05

	20% Quantile Coef. (SE)	40% Quantile Coef. (Std. Err.)	60% Quantile Coef. (Std. Err.)	80% Quantile Coef. (Std. Err.)
two month performance	0.289*** (0.020)	0.279*** (0.011)	0.228*** (0.012)	0.147*** (0.010)
performance	0.566*** (0.019)	0.611*** (0.011)	0.572*** (0.010)	0.365*** (0.009)
log10 performance	0.090*** (0.008)	0.096*** (0.006)	0.117*** (0.006)	0.125*** (0.006)
log10 redemptions	-0.160*** (0.010)	-0.173*** (0.007)	-0.241*** (0.008)	-0.267*** (0.007)
msci	0.581*** (0.017)	0.617*** (0.017)	0.954*** (0.020)	0.776*** (0.023)
vola	-0.168 (0.101	0.425*** (0.062)	1.255*** (0.065)	1.763*** (0.069)
gbi	-0.766*** (0.059)	-0.904*** (0.036)	-1.547*** (0.055)	-1.401*** (0.072)
gold	0.000 (0.022)	-0.002 (0.007)	0.027* (0.012)	0.055*** (0.013)
libor	-0.012*** (0.001)	-0.008*** (0.001)	-0.004*** (0.001)	0.000 (0.001)
Intercept	0.166*** (0.007)	0.222*** (0.010)	0.417*** (0.012)	0.709*** (0.012)
R-squared	0.4901	0.4261	0.3124	0.2542

5. Conclusion

During the financial crisis of 2007/2008, *money market funds*, *fixed income funds* and funds invested in convertible bonds *(convertible funds)* have been faced with the highest net redemptions of fund shares by investors ever witnessed. As the results of our investigations have shown, there exists strong evidence that investors behave in a selective manner when they decide whether to redeem their shares from funds.

In general, we find that the prior performance of funds had a negative and statistically significant influence on the net redemption of fund shares by investors over our observation period from March 2008 to April 2010. However, our results do not confirm the findings of previous publications such as Ippolito (1992) or Sirri and Tufano [1998]) that consumers are investing disproportionately more in funds that have been shown to perform very well during the previous reporting period, while failing to retreat from poorly performing funds at the same rate. This contradiction might be due to the high frequency of unfortunate events that led to substantial losses by the banking and fund industry during the financial crisis of 2008. Furthermore, lower information

costs for investors resulting from the rapidly growing availability of information via electronic media further enables investors to monitor markets themselves, and adjust their portfolios accordingly. Another change of investor behavior is evidenced in the increased number of investors that will abandon poorly performing funds as soon as those enter into a dip after a previous period of high performance. This research has identified the relatively recent emergence of pro-active investors who prefer to ensure the short-term profitability of their portfolios in favor of a prolonged exposure to risk as a fund's long-term performance is shifting from good to bad. The role that institutional investors play relating to this observation will be the subject of future research.

Our regression models do provide support for our hypothesis that investor attitudes are reflected in the categories of funds selected. Our measures of redeeming sensitivity, which relies on estimates of extreme value distributions, also indicate that a correlation does exist between investor behavior and fund categories.

Furthermore, our regression models provide some empirical evidence that the redemption of fund shares by investors in prior periods generally influences the more recent flows of funds. Therefore, our findings provide strong support for our proposal that redemptions of fund shares by a significant number of investors will result in a *domino effect* of further shares being redeemed during the following reporting period.

This results in the remaining investors having to accept further losses due to *fire sales*, which, in turn, will have substantial impact on the overall fund performance, and lead to further redemptions of fund shares (some basic studies on this issue have been completed by Edelen [1999] and Massa and Phallippou [2005]). Such amplifying effects might be quite similar to the effects of the self-accelerating spiral of liquidity risk within the global banking system under crisis circumstances described by Brunnermeier (2010).

To conclude our study, we would suggest that regulators should establish a strong framework to ensure that fund managers have a clearer idea of the different dimensions of liquidity risk such as redemption risk and market liquidity risk. It is worth noting that generating liquidity under strained market conditions in order to cover the liquidity needs incurred by the increasing number of redemptions of fund shares causes negative externalities for those consumers that remain invested in such tumbling funds, since they have to accept further losses caused by the additional unexpected liquidity costs. It may therefore be necessary to consider the introduction of a redemption fee, which

would, take the performance losses caused by the necessity of fund managers to cover liquidity needs in the event of high redemption ratios into account. An alternative would be the introduction of longer notice periods before investments can be switched. In order to offer further contributions to this particular discussion, we intend to examine the exact scale of such externalities in the next phase of our research work.

However, accepting that consumers punish poor performances of fund managers by significant redemptions of fund shares, fund managers should be obliged to hold a sufficient part of liquid assets at any time to cover such redemptions of fund shares.

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Leveraging and risk-taking behavior within the German banking system: Evidence from the financial crisis in 2007 and 2008

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Abstract

This study intends to examine whether the German banking system displays pro-cyclical behavior during 2000 to 2011, and to what extent specific sectors of the German banking system show significant balance sheet operations to increase their leverage during years of booming asset prices. The results of this study demonstrate that different sectors of the German banking system did operate their business more or less pro-cyclical. It also provides empirical evidence that certain banking sectors did favor refinancing their assets by short-term borrowing in the interbank market to increase their leverage during periods of extraordinary high returns in financial markets. Moreover, this study shows that banks, which operate above average leverages, tend to report a high volatility of return on assets and low distances-to-default.

JEL Classification Numbers: G01, G12, G14, G28, G15, G32

Keywords: Liquidity and leverage; financial crises and asset pricing; information and market efficiency; government policy and regulation; international financial markets; refinancing policy; financial risk and risk management; capital and ownership structure; counter-cyclical capital buffers; distance-to-default

1. Introduction

My paper focuses primarily on the leverages of banks, as examined, for example, by Adrian and Shin (2010), whose study of quarterly balance sheets of the five largest

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investment banks from 1991 to 2008 demonstrates the positive relationship between changes in leverage and balance sheet size. Within this context, *leverage* is defined as the ratio of the total assets to the amount of equity on the liability side of the banks' balance sheet. I propose the hypothesis that leveraging plays a central role in relation to different aspects of idiosyncratic and aggregate liquidity risk. My study begins with a brief literature survey to introduce the benchmarks, which frame my empirical studies of the German banking system.

Due to banks' continuously marking their balance sheets to market, leverage is by definition also continuously changing. Adrian and Shin distinguish between *passive* banks and *active* banks, i.e. banks that actively adjust the size of their balance sheet in accordance with leverage fluctuations. Active banks typically operate their balance sheets in a way that their leverage is high during episodes of global asset market booms providing extraordinarily high returns, and vice versa, resulting in a kind of pro-cyclicality. Adrian and Shin also demonstrate that banks usually adjust their balance sheet size by collateralized borrowing and borrowing in the interbank market.[3]

In order to illustrate the pro-cyclical balance-sheet operation by banks, let assume an initial balance sheet of a bank that reports a leverage of 10 (Leverage=Total Assets/Equity=100/10=10):

Assets	Liabilities
Securities, 40	Equity, 10
Other Assets, 60	Debt, 90

Now, suppose the bank is behaving passively during a period of booming assets. In this case, the leverage equals 8.5 (Leverage=Total Assets/Equity=102/12=8.5):

Assets	Liabilities
Securities, 42	Equity, 12
Other Assets, 60	Debt, 90

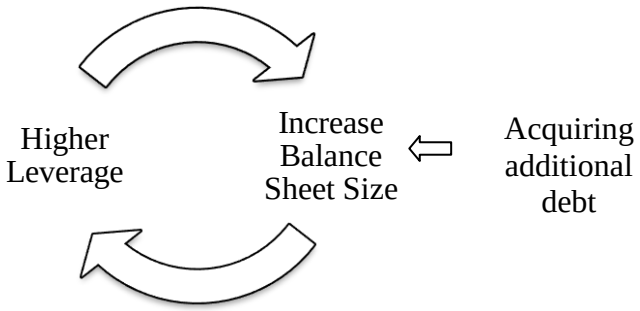
[3] The volume of residual mortgage backed securities (home mortgages) alone increased from about 500 billion USD in 2004 up to more than 2200 billion USD in 2007 (OECD [2008]). The S&P 500 reported gains of 68.08% from 2003 to 2007 (extracted from Bloomberg).

By contrast, a bank keeping the leverage on a constant level will adjust its balance sheet by appropriate balance sheet operations. In this case, the leverage equals 10 although assets are booming (Leverage=Total Assets/Equity=120/12=10):

Assets	Liabilities
Securities, 60	Equity, 12
Other Assets, 60	Debt, 108

Thus, passive banks will report decreasing leverage ratios during periods of asset growth. By contrast, banks that are actively adjusting their balance sheets are reporting increasing leverage ratios over the same period. As Adrian and Shin (2010) demonstrate, banks tend to adjust their balance sheets and report higher leverages during periods of booming assets. As the authors illustrate, leverage targeting would entail upward-sloping demands and downward-sloping supplies: *'The perverse natures of the demand and supply curves were even stronger when the leverage of the financial intermediary is pro-cyclical - that is, when leverage were high during booms and low during busts'* (for further details see Adrian & Shin [2010]):

Figure 1: Pro-cyclical leveraging during periods of asset growth (see also Adrian and Shin [2010])



As Rajan (2006) or Schmielewski and Wein (forthcoming) suggest, the pro-cyclical behavior of banks should be discussed within the context of numeration schemes and principal-agency problems of the banking system. In circumstances that encourage agents to invest in risky long-term assets it seems more likely that they will behave pro-cyclically by increasing leverage during periods when asset markets are providing

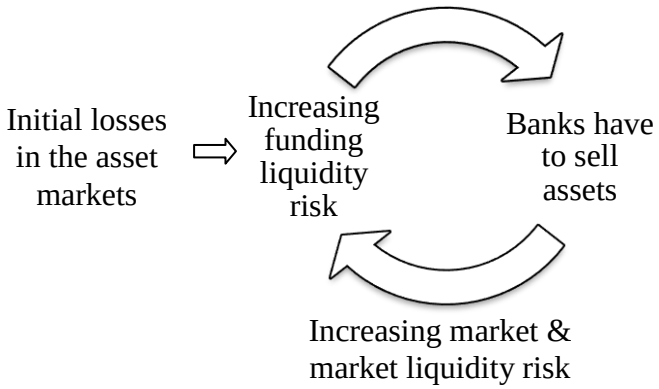
extraordinarily high returns, and market risk appears to be relatively low. Furthermore, the business models of distinguishable banking sectors should relate to the leverage ratio during booming asset markets. Banks that are focusing on investment banking activities to a greater degree and that are reporting global activities in the asset markets appear to tend showing a more pro-cyclical behavior than banks that are mainly involved in regional project-financing activities (Fonteney [2007], Cihák and Hesse [2007]). The German banking system, for instance, grounds on different clearly distinguishable pillars with different business models. While German major banks are globally operating investment activities, other sectors of the German banking systems, e.g. *Sparkassen*, regional banks or cooperatives, are exclusively focusing on financing of projects of locally operating firms and retail clients. A clarifying showcase for the influence of the preferred business model on the risk-taking behavior of banks provides the sector of German *Landesbanken*. These banks constitute one major pillar of the German banking system by holding a significant part of the total assets reported by German banks. *Landesbanken* had completely to adopt their business model due to legislative changes of the so-called 'Gewährträgerhaftung' reflecting a guarantee by the public founding entity in the case of a default (see, for example, Hüfner [2010] or Hardy and Howarth [2009]). In one of the most recent studies, Binici and Köksal (2012) confirm the relationship of the business model to leverages for the Turkish banking system by showing that the leverages of participation banks are counter-cyclical, whereas the leverages of commercial banks and development/investment banks are pro-cyclical. Another important influencing factor on the leverage of the different banking sectors appears to be the change from traditional local GAAP to International Financial Reporting Standards (IFRS), as suggested, for example, by Bushman and Williams (2009).

Moreover, the illustrated balance sheet arithmetic and figure 1 demonstrate that during periods of actively leveraging, banks tend to take on an increasing amount of debt with short-term maturities on the liability side of the balance sheet, and look for potential returns by lending this money to borrowers, who are willing to pay above average interest rates. This was evident, for instance, during the financial crisis in 2008 in case of sub-prime mortgage-backed securities. Adrian and Shin (2010) also show that

rising leverages within the financial system closely relate to the Value-at-Risk (VaR) of banks, and that this represents one of the major risk indicators of banks` assets.[4]

In more detail, to carry out leverage adjustments during periods of increasing asset prices banks need to acquire additional short-term debt such as by looking for additional borrowings from non-banks, and collateralized or unsecured borrowings from other banks in the global interbank market. Such behavior relates to increasing interconnectivity, and funding liquidity risk of the banking system as a whole. The pro-cyclical nature of leverage is therefore an important cause of the fragility of the banking system, as both Arian and Shin (2010) and Cifuentes, Ferrucci and Shin (2005) have established. As seen during a number of financial crises over the past decades, relative small shocks in asset markets can induce systemic crises, that are well-examined by a number of research papers.[5] These papers are focusing primarily on the role of asset prices during episodes of tumbling markets with respect to the aggregate and idiosyncratic liquidity of financial intermediaries. Cifuentes, Ferrucci and Shin (2005) underscore that asset sales by distressed financial institutions will lead to a further decline of asset prices if the demand of financial markets for illiquid assets is not perfectly elastic. This is consistent with Adrian and Shin (2010), Gorton (2008), and Brunnermeier (2009) who emphasize that de-leveraging of banks by selling assets under tensioned market conditions can result in further declines of asset prices.

Figure 2: Increasing funding and market liquidity risk of highly leveraged banks during periods of busting asset markets (see also Brunnermeier [2009])



[4] Calculating the Value-at-Risk (VaR) is the preferred measurement of market risk within the Basel II accord; see Bank for International Settlement (2005).
[5] For further details on the chronology and reasons of financial crises see, for example, Morris and Shin (2009) or Brunnermeier (2009).

Both Brunnermeier (2009) and Gorton (2008) argue that highly leveraged banks in particular bear a tremendous funding liquidity risk that may enforce a self-amplifying spiral in the asset markets that is illustrated in figure 2. As Gorton highlights, increasing funding liquidity risk results in banks actually facing bank runs similar to the classic panics of the 19th and early 20th centuries. These researchers characterize bank runs by the fact that the holders of short-term liabilities refuse to fund banks. In contrast to the classic panics that have been the object of intensive research work, 'modern bank runs' seem to involve the refinancing opportunities in the interbank market instead of, or in addition to, withdrawals of deposits by non-bank consumers.

Upper and Worms (2004), for example, have established the domino-effect that is created when banks which are hit by a liquidity shock try to meet their liquidity needs by withdrawing their deposits from other banks, rather than liquidating long-term assets under strained market conditions.[6] In the scientific literature, little attention has been paid so far to the role of the interbank market as a contributory factor in times of financial crisis over the past years. Following the financial crisis of 2007/2008, however, research papers are increasingly beginning to investigate the consequences of freezes in, or the drying up of, the interbank market during financial crises, when banks stop trading with each other (Abassi and Schnabel [2009]). Allen, Carletti and Gale (2009), for example, propose a model of the interbank market that explains the excess volatility of prices, which occurs particularly when banks are failing to hedge their extraordinary aggregate and idiosyncratic liquidity demands in circumstances of financial crises.

By contrast, very little research has so far been undertaken that examines the possibility of leverages as a contributing factor in the German banking system. Of the few pertinent publications, Upper and Worms (2004) have investigated the connection between credit risk and interbank lending as a potential source of contagion risk within the German banking system by estimating bilateral relationships on the basis of banks` balance sheets. The authors emphasize that institutional guarantees may reduce contagion within the German banking systems but cannot avoid it entirely. Their empiric work shows that the failure of a single bank could lead to a significant

[6] Such 'modern bank runs' might be caused on information asymmetries about counterparty risk, as pointed out, for example, by Heider, Hoerova and Holthausen (2009). This is consistent with Freixas and Holthausen (2005), who explain that market imperfections such as liquidity shortages or interest rate differentials could mainly be contributed to asymmetric information between different countries.

breakdown of the German banking system on the grounds that it could induce a loss of up to 15% of total assets of the German banking system.

In conclusion, it can be stated that there is a number of studies published, which examine the relationship between leverage and liquidity, and corresponding balance sheet operations of banks. The influence of asset prices under strained market conditions on aggregate or idiosyncratic liquidity, the role of the interbank market for the distribution of liquidity and monetary policy, as well as the risk of contagion during financial markets crises and their underlying mechanisms are also all the subject of major on-going research. On the other hand, however, little work has been undertaken so far that addresses the pro-cyclical behavior of German banking sectors, taking into account the leverage of the balance sheets of different categories of banks. Apart from Upper and Worms (2004), who explain the danger of contagion across the whole of the German banking system, no empirical studies have been conducted so far that examine the susceptibility of German banking sectors due to the pro-cyclical behavior of banks and the role of different refinancing sources, particularly over the course of the financial crisis of 2007/2008.

To fill this knowledge gap, the focus of my study is primarily on determining whether the German banking system does indeed display evidence of pro-cyclical behavior between 2000 and 2011. In particular, I intend to show that specific sectors of the German banking system engaged in significant balance sheet operations to increase their leverage during years of booming asset prices while other banking sectors do not trust on a pro-cyclical behavior. This hypothesis primarily grounds on the assumption that the degree of pro-cyclical leveraging might relate to the different business models, ownership structures or the market enviroment of the different German banking sectors. In other words, I expect that globally operating banking sectors, like German major bank, subsidiaries of international banking holdings or *Landesbanken*, showed a pro-cyclical behavior between 2000 and 2011 while other banking sectors, for example *Sparkassen*, regional banks or cooperatives, preferred a passive strategy that is reflected by low leverages during years of booming asset markets. In addition, my study highlights some of the consequences of pro-cyclical leveraging during the sub-prime

crisis of 2007/2008.[7] Finally, I aim to analyze the available empirical data for evidence of readily discernible refinancing policies among specific sectors of the German banking system that have resulted in directly increasing the funding liquidity risk within these banking sectors.[8] As stated earlier, the significant liquidity demands of the banking sector during 2007 and 2008 were caused primarily by 'modern bank runs' that involved weakening refinancing opportunities in the interbank market instead of, or in addition to, withdrawals by non-bank depositors. For this reason, I am also examining the role of banks' preferred non-bank and institutional refinancing policies within specific sectors of the German banking system.[9] This aspect of my study will have significant impact for the industry, because refinancing in the interbank market remains one of the most important channels of contagion risk within the global banking industry.

In Section 2, following, I will outline the sources and structure of the examined data, as well as the applied methodologies. Section 3 will summarize the data, compile the results and assess those results within the scope of my proposed hypothesis.

2. Data

The data, on which this study is based, has been provided by the Bundesbank Statistics Department. It covers several balance sheet items submitted by German banks between 2000 and 2010 on a monthly basis. In order to test my hypothesis I have used data, which has been aggregated, at the level of the various German banking sectors including those typical for this country alone (German major banks, regional banks, *Landesbanken*, *Sparkassen*, cooperatives). Although the aggregated data examined within my study do not allow any conclusions on risk-taking behavior of an individual bank the results appear to be helpful to characterize the different sectors of the German banking industry (German major banks, *Sparkassen*, cooperatives, *Landesbanken*, regional banks and International bank holdings).

In order to prepare the ground for my study I am first of all showing a number of descriptive statistics to introduce the structure and dynamics of leverages within the German banking system from 2000 to 2010, whereas my study focuses primarily on the

[7] Adrian and Shin (2010) have examined such high leverages over the sub-prime mortgage crisis in 2007/2008 in the event of globally operating investment banks.
[8] Brunnermeier and Pedersen (2009), for example, highlight the dependency between market and funding liquidty risk.
[9] Diamond and Dybvig (1983) provide seminal research on the role of withdrawals of deposits by early and late consumers.

changes that occurred immediately prior to, and during the financial crisis of 2007/2008. In order to prove my theory that banking specific variables and financial market indicators can both affect the leverage of banks' balance sheets I apply a number of least square regressions. Table 1 describes the independent variables that have been applied to these regressions.[10] I further intend to establish the so-called 'distance-to-default' of the different banking sectors as a recognized probability indicator of the likelihood of a bank defaulting.

Table 1: Dependent and independent variables

Variable	Definition	Calculation formula/Source
Leverage (dependent variable)	Ratio of total assets to capital	$\text{leverage} = \frac{\text{total assets}}{\text{bank capital}}$
Banking sector	Sectors of the German banking system as defined by the Deutsche Bundesbank	Cooperatives Landesbanken Regional banks Sparkassen German major banks International bank holdings
Repospread	Monthly spread between interest rates of repurchase agreements (with a three month maturity) and monthly libor rate	extracted from Bloomberg[11]
ROA	Ratio of return to total assets	$\text{ROA} = \frac{\text{return}}{\text{total assets}}$
Libor3m	Monthly libor rate (three month maturity)	extracted from Bloomberg
MSCI	Monthly percentage changes of the MSCI World	extracted from Bloomberg
GBI	Monthly percentage changes of the Global Bond Index	extracted from Bloomberg
Current yield 10y	Monthly current yield of 10 year benchmark bonds	extracted from Bloomberg

To test the sample for collinearities I am providing the calculations pertaining to the Variance Inflation Factors (VIF) in Table 2. The Variance Inflation Factors demonstrate that the independent variables show only weak collinearities, if any.

[10] I have conducted all regressions with STATA 11 software.
[11] Bloomberg PLC is one of the leading providers of financial market information.

Table 2: Variance Inflation Factors (VIF)
This table reports the Variance Inflation Factors (VIF) to test the dependent variables on collinearities. The Variance Inflation Factors have an intuitive interpretation. Variance Inflation Factors less than 5 indicates that the independent variable shows only weak collinearities, if any.

Variable	VIF	1/VIF
ROA	2.39	0.4177
MSCI	1.62	0.6156
GBI	1.53	0.6541
Libor3m	9.54	0.1048
Repospread	3.31	0.3018
Current yield 10y	8.21	0.1218
2003	1.91	0.5248
2004	2.10	0.4767
2005	2.93	0.3418
2006	2.20	0.4542
2007	2.08	0.4799
2008	3.83	0.2609
2009	4.40	0.2270
2010	4.85	0.2060
GB	1.84	0.5421
AB	1.67	0.5986
GEN	1.70	0.5872
LB	1.90	0.5252
SPK	1.67	0.5995
Mean VIF	3.14	

3. Analysis and Results

The following sections illustrate the calculations, based on descriptive statistics and regression models that I have used to examine the risk-taking behavior of German banks over the period 2000 to 2011, with particular focus on refinancing strategies and leveraging of the balance sheets.

Table 3 provides an overview of the annual leverages of selected sectors of the German banking system over the period under examination. Column 1 of Table 2 exhibits the leverages of the entire German banking system. The data show that the German banking system generally reported persistent values during the analysis period, with peaks in 2000/2001 and 2005. The highest value of leverages occurred in 2000; the indicated decline of leverages in the period 2001 to 2003 can be put down to the bursting *internet bubble*, and the subsequent crisis in financial markets because of the breakdown of this new economy.

To be more precise, the German major banks have tended to increase their leverage from 2000 to 2005, returning only slightly lower values between 2005 and 2007, with a significant reduction of leverages in 2008 and 2009. Regional banks, *Sparkassen* and

cooperatives appear to have reduced their leverage consistently over the entire period in question, showing lower values in 2008 than any of the other banking sectors.

It is interesting to note that *Landesbanken* as banks controlled by federal state authorities, report the highest level of leverages in 2008. Table 3 indicates significant increases in leverages between 2003 and 2008 by corresponding balance sheet operations. This pattern reveals that during this period *Landesbanken* operated their business at the same level of leverages that can be observed as major banks or international bank holdings.

This observation is of major significance, especially in light of the fact that the Financial Market Stabilization Fund, or SoFFin established by the German Government in 2008, had to bail out several *Landesbanken* in order to stabilize the German banking industry in the aftermath of the financial crisis of 2008.

Table 3: Leverages of German banking sectors
This table shows leverages (defined as total assets /capital) of different German banking sectors from 2000 to 2011 as of January each year (GB=German major banks, RB=regional banks, LB=Landesbanken, SPK=Sparkassen, GEN=cooperatives, AB=international bank holdings).

Year	Total	GB	RB	LB	SPK	GEN	AB
2000	24.10	15.60	18.34	26.36	23.94	20.18	22.47
2001	23.71	15.59	19.53	25.41	23.12	19.38	31.42
2002	22.91	15.39	18.84	23.52	22.70	19.64	28.49
2003	21.77	15.80	18.61	20.44	21.88	19.34	28.77
2004	22.28	18.81	18.12	21.52	21.31	18.58	29.30
2005	23.35	24.56	16.51	22.80	20.72	18.22	31.18
2006	21.65	24.22	15.45	22.60	20.10	17.81	25.12
2007	21.39	21.96	16.01	23.23	19.36	17.03	25.89
2008	21.61	22.44	16.81	24.38	18.82	16.57	23.85
2009	21.16	17.90	21.52	22.94	18.68	17.23	20.07
2010	20.37	18.80	18.60	19.61	18.46	17.31	18.83
2011	21.39	24.05	17.60	22.17	17.86	16.72	20.34

Table 4 compares the increases in leverages with the contemporaneous growth on the asset side of banks' balance sheets between 2000 and 2008. In general terms, this table demonstrates the important role played by German major banks and *Landesbanken* within the German banking system due to their high volume of total asset. In more detail, Table 4 illustrates that both German major banks and International bank holdings increased their total assets at above average levels. A similar increase can also be observed in the case of the regional banks. In this case, however, this trend is less

significant than it would be in other banking sectors because regional banks only hold a small section of the entire volume of assets of the German banking system.

In the case of international bank holdings, the significant increase of total assets could be seen as a reflection of the increasing globalization of the international banking system, which recent literature has repeatedly cited as one reason of the increased risk of contagion over the last decade. In contrast to all of the above, the exclusively locally operating cooperatives and *Sparkassen* distinguish themselves by showing the lowest increase in the asset side of their balance sheets.

Generally speaking, my data in Table 3 and in Table 4 confirm that certain sectors of the German banking systems, the German major banks, *Landesbanken*, and International bank holdings did manage their balance sheets pro-cyclically by increasing the volume of total assets during periods of booming asset prices.

Table 4: Volumes of total assets reported by German banking sectors
This table reports volumes and annual changes (Chg %) of total assets reported by different German banking sectors in billions of Euro from 2000 to 2011 as of January each year (GB=German major banks, RB=regional banks, LB=Landesbanken, SPK=Sparkassen, GEN=cooperatives, AB=international bank holdings).

Year	Total	Chg %	GB	Chg %	RB	Chg %	LB	Chg %
2000	5,767,212		849,872		523,144		1,138,990	
2001	6,126,775	6.23%	993,401	16.89%	607,252	16.08%	1,207,151	5.98%
2002	6,336,457	3.42%	1,012,261	1.90%	633,227	4.28%	1,271,535	5.33%
2003	6,420,338	1.32%	1,058,460	4.56%	662,252	4.58%	1,312,725	3.24%
2004	6,487,954	0.42%	1,057,574	0.49%	676,702	1.82%	1,361,423	1.66%
2005	6,718,976	3.95%	1,251,463	18.41%	576,110	-14.99%	1,280,280	-4.84%
2006	6,981,158	3.90%	1,265,120	1.09%	603,185	4.70%	1,368,351	6.88%
2007	7,226,573	3.52%	1,313,293	3.81%	623,436	3.36%	1,454,463	6.29%
2008	7,628,615	5.56%	1,438,948	9.57%	686,427	10.10%	1,563,074	7.47%
2009	7,970,371	4.48%	1,482,739	3.04%	786,113	14.52%	1,578,219	0.97%
2010	7,525,485	-5.58%	1,308,947	-11.72%	724,028	-7.90%	1,449,849	-8.13%
2011	8,232,993	9.40%	2,007,247	53.35%	740,621	2.29%	1,450,591	0.05%
2000-2008		38.20%		74.47%		50.27%		38.56%

Table 4: continued

Year	SPK	Chg %	GEN	Chg %	AB	Chg %
2000	914,212		527,803		236,237	
2001	932,721	2.02%	525,338	-0.47%	279,985	18.52%
2002	969,035	3.89%	543,791	3.51%	299,524	6.98%
2003	976,721	0.79%	554,933	2.05%	382,200	27.60%
2004	982,036	0.50%	561,602	1.14%	377,617	-2.64%
2005	988,201	0.40%	572,222	2.07%	432,370	13.21%
2006	1,000,474	1.24%	586,583	2.51%	732,858	69.50%
2007	1,009,455	0.90%	603,563	2.89%	802,269	9.47%
2008	1,023,036	1.35%	623,108	3.24%	858,363	6.99%
2009	1,058,231	3.44%	666,509	6.97%	891,500	3.86%
2010	1,064,855	0.63%	688,922	3.36%	812,448	-8.87%
2011	1,072,737	0.74%	700,216	1.64%	900,096	10.79%
2000-2008		15.75%		26.28%		277.38%

Within the context of expansion of the asset side of banks` balance sheets it is important to assess the different refinancing sources of banks, particularly with regards to the tensions in the interbank market as a refinancing channel during the financial market turbulences in 2008 as examined, for instance, by Abassi and Schnabel (2009). Thus, Table 5 differentiates the percentage of short-term refinancing in the interbank market in the different banking sectors between 2000 and 2011. With respect to the whole of the German banking system, the percentage of short-term refinancing appears persistent from 2000 to 2009 at around 28%, with a sharp decline in 2010 and 2011 resulting from the increasing distrust in the interbank market. As the table shows, German major banks, *Landesbanken* and International bank holdings report the highest percentage of short-term refinancing in the interbank market, while locally operating *Sparkassen*, regional banks and cooperatives make relatively little use of this refinancing channel.

Table 5: Short-term refinancing in the interbank market by German banking sectors
This table shows the percentages of short-term refinancing in the interbank market of different German banking sectors from 2000 to 2011 as of January each year (GB=German major banks, RB=regional banks, LB=Landesbanken, SPK=Sparkassen, GEN=cooperatives, AB=international bank holdings).

Year	Total	GB	RB	LB	SPK	GEN	AB
2000	28.42%	36.41%	32.58%	36.33%	22.14%	14.23%	49.39%
2001	28.63%	38.71%	30.76%	35.18%	23.77%	14.86%	48.55%
2002	28.37%	37.61%	29.41%	36.29%	22.97%	14.13%	45.22%
2003	28.62%	40.60%	28.65%	35.07%	22.42%	13.70%	35.85%
2004	28.05%	40.64%	29.70%	33.28%	22.50%	13.17%	36.80%
2005	28.07%	37.70%	31.20%	32.94%	21.89%	12.86%	36.14%
2006	28.25%	37.35%	29.24%	33.21%	21.95%	13.13%	32.33%
2007	28.21%	36.17%	27.22%	35.62%	20.80%	12.99%	33.33%

Table 5: continued

Year	Total	GB	RB	LB	SPK	GEN	AB
2008	28.55%	36.63%	22.92%	37.73%	19.45%	12.98%	33.51%
2009	28.48%	34.84%	24.58%	32.75%	19.53%	15.37%	36.83%
2010	27.00%	34.52%	20.69%	30.25%	18.66%	15.38%	33.21%
2011	23.80%	22.88%	19.98%	27.53%	17.40%	14.10%	30.95%

Table 6 summarizes the uptake of an additional source of banks` refinancing in the form of short-term refinancing raised by acquiring savings or short-term deposits from the non-banking sector. This shows the locally operating *Sparkassen*, regional banks and cooperatives as relying on this type of refinancing to a higher degree than German major banks and International bank holdings did. It is interesting to note that *Landesbanken* show the lowest percentages of short-term non-bank refinancing uptake over the entire observation period, but with a significant increase from 2008 to 2011. The growing importance of non-banks as a refinancing source for *Landesbanken* during those years can be explained by the necessary change in their refinancing policies as a result of the increasing distrust of the interbank market.

Table 6: Short-term non-bank refinancing by German banking sectors in percentage of total assets
This table reports the short-term non-bank refinancing by German banking sectors in percentage of totals assets from 2000 to 2011 as of January each year (GB=German major banks, RB=regional banks, LB=Landesbanken, SPK=Sparkassen, GEN=cooperatives, AB=international bank holdings).

Year	Total	GB	RB	LB	SPK	GEN	AB
2000	21.63%	22.68%	36.38%	7.37%	49.40%	56.72%	16.78%
2001	20.45%	21.85%	31.65%	7.66%	46.44%	53.93%	15.19%
2002	21.65%	23.58%	34.67%	7.74%	48.65%	56.35%	18.24%
2003	22.26%	23.48%	37.79%	7.15%	49.66%	57.16%	19.63%
2004	23.18%	25.80%	38.51%	7.63%	50.58%	58.40%	24.21%
2005	23.77%	30.94%	37.88%	8.16%	50.85%	58.61%	25.36%
2006	24.04%	32.00%	39.08%	8.81%	51.27%	59.19%	26.24%
2007	23.89%	31.37%	40.82%	9.49%	50.29%	57.49%	26.94%
2008	24.41%	31.73%	43.52%	10.51%	49.71%	57.00%	28.91%
2009	25.24%	30.72%	41.82%	14.05%	50.93%	57.52%	31.35%
2010	26.72%	30.72%	46.65%	14.32%	54.59%	58.35%	33.96%
2011	25.82%	21.14%	46.64%	14.00%	57.39%	61.55%	32.58%

To summarize so far, I have established that refinancing sources have two dimensions which are closely related to the distinguishable sources of funding liquidity risk that are the kind of fundraising (non-bank refinancing or refinancing in the interbank market) and the time horizon of refinancing. Therefore, Table 7 compares the total percentages of non-bank refinancing in a short term and refinancing in the interbank market by the various banking sectors. My results demonstrate a general increase in short-term

refinancing from 2000 to 2011 with greater recourse to this type of refinancing in 2008 to 2011. Some researchers explain this significant expansion of short-term refinancing particularly from 2008 to 2011 by reminding of the increasing distrust in the interbank market (see Abassi and Schnabel [2009] or Acharya, Gale, and Yorulmazer [2010]). This hypothesis seems to relate to the presumption of decreasing creditworthiness of banks by financial market participants that during periods of shrinking confidence only accept to borrow money on a short-term basis, particularly in a strained interbank market. Such a trend should be of major interest to regulatory authorities, because the risk of maturity mismatches increases in correspondence with the percentage of short-term refinancing of a bank.

More precisely, *Landesbanken*, German major banks and International bank holdings appear to rely on short-term refinancing to a growing extent, while regional banks, *Sparkassen* and cooperatives show consistently high percentages of short-term refinancing from 2000 to 2008. These differing funding policies coincide with the different business models of German banking sectors that I discussed in section 1 of this paper. *Landesbanken*, German major banks and International bank holdings are focusing on global investment activities while regional banks, *Sparkassen* and cooperatives are mainly targeting on financing regional projects of firms and retail clients.

Table 7: Short-term refinancing by German banks in percentage of total assets
This table shows the yearly short-term refinancing by German banks in percentage of total assets from 2000 to 2011 as of January each year, where GB=German major banks, RB=regional banks, LB=Landesbanken, SPK=Sparkassen, GEN=cooperatives, AB=international bank holdings.

Year	Total	GB	RB	LB	SPK	GEN	AB
2000	50.05%	59.09%	68.95%	43.69%	71.54%	70.95%	66.17%
2001	49.08%	60.56%	62.41%	42.85%	70.21%	68.79%	63.74%
2002	50.02%	61.18%	64.07%	44.03%	71.62%	70.48%	63.47%
2003	50.88%	64.08%	66.44%	42.22%	72.08%	70.86%	55.48%
2004	51.23%	66.44%	68.22%	40.92%	73.08%	71.57%	61.00%
2005	51.84%	68.63%	69.08%	41.10%	72.74%	71.63%	61.50%
2006	52.29%	69.35%	68.31%	42.02%	73.22%	72.32%	58.56%
2007	52.10%	67.54%	68.04%	45.11%	71.08%	70.48%	60.28%
2008	52.96%	68.35%	66.44%	48.24%	69.16%	69.98%	62.42%
2009	53.72%	65.56%	66.40%	46.80%	70.46%	72.89%	68.18%
2010	53.72%	65.25%	67.34%	44.57%	73.25%	73.74%	67.17%
2011	49.62%	44.01%	66.62%	41.53%	74.79%	75.65%	63.53%

My next calculation applies the ordinary least squares regressions with the purpose of clarifying influences on banks' leverages over the observation period in more detail.

Table 8 displays the result of a regression of several financial market indicators on the leverages of the different banking sectors from 2000 to 2010. Additionally, I apply a factored variable for the distinguishable banking sectors (regional banks are the basis of the factored variable), as well as introducing dummy variables in the regression model for every single year from 2003 to 2010. To facilitate comparison, I am also including the corresponding standardized beta coefficients in this table.

Table 8: Ordinary least squares (OLS) regression
This table shows the results of an ordinary least square (OLS) regression on leverages over the period from 2001 to 2009. The sample covers 804 monthly observations. Significance levels are marked with *** (P>t) <=0.01, ** (P>t) <=0.05 and * (P>t) <=0.1. The regression provides an r-squared of 0.6188, an adjusted r-squared of 0.6094, and a root MSE of 0.1886.

	Coef.	Std. Err.	P>|t|	Beta
ROA	0.13	0.47	0.7870	0.0091
MSCI	-1.04	2.16	0.6320	-0.0132
GBI	-0.77	4.90	0.8750	-0.0042
Libor3m	0.35	0.20	0.0740	0.1244*
Repospread	0.06	0.44	0.8880	0.0055
Current yield 10y	-0.25	0.35	0.4660	-0.0502
2003	-0.48	0.48	0.3120	-0.0367**
2004	0.85	0.51	0.0980	0.0645*
2005	0.68	0.63	0.2820	0.0516
2006	-1.20	0.49	0.0150	-0.0915**
2007	-1.51	0.42	0.0000	-0.1148***
2008	-2.07	0.56	0.0000	-0.1578***
2009	-1.84	0.77	0.0170	-0.1400**
2010	-2.18	0.86	0.0120	-0.1659**
GB	1.13	0.30	0.0000	0.1119***
AB	7.69	0.28	0.0000	0.7586***
GEN	-0.08	0.29	0.7760	-0.0081
LB	4.98	0.30	0.0000	0.4916***
SPK	2.37	0.28	0.0000	0.2334***
Intercept	18.80	1.63	0.0000	

My regression confirms that leverages of German banks do relate to their corresponding banking sectors. Apart from cooperatives, the different banking sectors enter the regression with positive and statistically significant coefficients. Not surprisingly, International bank holdings and *Landesbanken* record the highest standard beta coefficients, while German major banks and *Sparkassen* return statistically significant, but relatively low coefficients. This would indicate that International bank holdings and *Landesbanken* operated their business highly leveraged. Conversely, the sectors of *Sparkassen*, German major banks and cooperatives display statistically significant and negative coefficients. These observations are consistent with the results illustrated in Table 3, which have already shown the relatively low tendency of *Sparkassen*, German

major banks and cooperatives towards leverage. Particularly, if I keep in mind that I have chosen regional banks as the basis of the factored variable for ‘banking sectors’ the results appear to be plausible.

The analysis has established a strong relationship between the dummy variables for every single year, and leverages of German banking sectors especially for the period from 2005 to 2010. Surprisingly, the obtained standard beta coefficients indicate a significant decrease of leverages from 2006 to 2010. When taking into account the leverages of the entire German banking system as illustrated in Table 3, however, it becomes apparent that the risk-taking behavior of German banks is diverse, and depends entirely on the individual banking sector. By contrast, this regression model provides only weak support for the supposition that leverages of banks correlate with the financial market indicators. Only the global bond index (‘GBI’) shows a statistically significant influence on banks’ leverages, even though the obtained coefficient is relatively low.

The next table analyzes the regression models for every single banking sector, including a dummy variable, for every single year from 2003 to 2010, in order to illuminate further the pro-cyclical behavior of the German banking sectors, and their relationship to the variety of financial market indicators. The results reported in Table 9 underline the counter-cyclical behavior of *Sparkassen* and cooperatives by reducing their leverages over the period 2003 to 2010 and reporting a strong growth of assets during the same period that is listed in Table 4. German major banks, on the other hand, appear to have increased their leverage, since this banking sector report statistically significant and positive standard beta coefficients, particularly between 2005 and 2007 with a significantly increasing volume of total assets. In the case of International bank holdings and regional banks, the regression models suggest that these banking sectors significantly expanded their leverage in 2005 and in 2004 respectively, and de-leveraged their balance sheets between 2006 and 2010 while reporting a significant growth of assets. By contrast, *Landesbanken* show pro-cyclical behavior in 2004 to 2005 and counter-cyclical behavior from 2008 to 2009, because the related dummy variables obtain statistically significant and positive standard beta coefficients for the period 2003 to 2005, while these variables enter the regression with statistically significant but negative coefficients for the period 2006 to 2007.

In addition, financial market indicators and the return on assets appear to influence the leverage of the different banking sectors in a distinguishable direction, and to a different degree. The 'return on assets' (ROA) appears to be influencing the leverages of International bank holdings, *Landesbanken*, and regional banks in a positive manner. Particularly International bank holdings and *Landesbanken* achieve a relatively high standard beta coefficient, which appears to support my hypothesis that return on assets represents a significant factor in the expansion of their balance sheets (see also Binici and Köksal [2012]).

Moreover, the variable that is representing the global bond markets ('GBI') seems to show significant influence on the leverage of *Landesbanken*, while the global stock market indicator ('MSCI') would appear to stand in significant relation to the leverage of regional banks and International banking holdings.

Interestingly, the leverages of German major banks, International banking holdings, *Landesbanken*, cooperatives and *Sparkassen* are closely tied to the independent variables for interest rates such as the libor 3 month deposit rate ('libor3m'), while the current yield of bonds with a 10 year maturity ('current yield 10y') relates to cooperatives, regional banks, and *Sparkassen*. Finally, the spread between secured repurchase agreements and unsecured interbank borrowing ('repospread') show a significant influence on leverages of cooperatives, regional banks, and *Sparkassen*. These inter-dependencies may be explained by the fact that the business strategies of the different banking sectors are spotlighted on attaining interest rate gains to a different degree.

In summary, it can be stated that there does appear to be a link between the leverage of a bank, and the banking sector it operates in. Furthermore, it seems likely that each banking sector is adjusting its leverage to a different degree depending on various financial market indicators. This variation in risk-taking behavior is likely to be due to the varying business models of the banking sectors in question, and the corresponding ownership structures of banks (see Schmielewski and Wein [forthcoming]).

Table 9: Ordinary least squares (OLS) regressions for different banking sectors
This table shows the results of ordinary least squares (OLS) regressions on leverages over the period from 2001 to 2009. The sample covers 804 monthly observations. Significance levels are marked with *** (P>t) <=0.01, ** (P>t) <=0.05 and * (P>t) <=0.1.

	GB	AB	GEN	LB	RB	SPK
ROA	-0.0042	1.1319***	-0.1954***	4.0723***	0.3608**	-0.2977***
MSCI	0.0350	-0.0843**	-0.0034	0.0399	-0.1088**	-0.0041
GBI	-0.0318	-0.0297	0.0111	0.0194***	0.0080	-0.0015
Libor3m	0.2715**	-0.2483***	-0.3442***	1.1110***	0.0548	-0.1527***
Repospread	-0.0427	-0.0840	0.1074***	-0.0125	0.3882***	0.0381*
Curr. yield 10y	0.0216	-0.2231**	0.1353***	0.0847	0.0001	0.1525***
2003	0.2175	-0.1117**	-0.1554***	0.0675	-0.2529***	-0.1430***
2004	0.5799	0.1911***	-0.3926***	1.8474***	0.0684	-0.4448***
2005	0.9627***	0.1116	-0.4354***	1.0760**	-0.4241***	-0.4458***
2006	0.6371**	-0.2306***	-0.4570***	-0.3344**	-0.6035***	-0.4987***
2007	0.5476***	-0.1215***	-0.5872***	-1.3556***	-0.4929***	-0.6340***
2008	0.4068	-1.2625**	-0.6861***	0.4629***	-0.3471***	-0.7185***
2009	0.3957	-0.2367***	-0.7710***	3.0900***	0.2326**	-0.9255***
2010	0.4866	-0.7218***	-0.7303***	2.8316***	0.2282**	-0.8158***
R-Squared	0.8803	0.9028	0.9740	0.8000	0.8410	0.9834
Adj. R-Squared	0.8660	0.8912	0.9709	0.7760	0.8220	0.9814
Intercept	13.18	33.32	20.17	13.78	17.42	24.04

A considerable amount of literature is focusing on principal-agent problems within the banking system. Some papers have tried to define the relationship between ownership structures and risk behavior in terms of the so-called z-score (distance-to-default, DD), as described, for example, in Boyd and Graham's seminal paper of 1986 as an appropriate measure of a bank's probability of default. The distance-to-default (DD) is calculated from the annual return-on-assets (ROA), the ratio of common equity to total assets (CAR) and the standard deviation of return-on-assets (σROA):

$$DD = \frac{CAR+ROA}{\sigma ROA}$$, whereas $$ROA = \frac{yearly\ return}{total\ assets}$$ and $$CAR = \frac{common\ equity}{total\ assets}$$.

Thus, the somewhat intuitive z-score estimates the number of standard deviations the annual return-on-assets figures can fall, before the common equity of a bank turns negative. Table 11 applies this risk measure to the various banking sectors; the distances-to-default calculations are based on the profit and losses listed in Table 10.

From these tables it becomes apparent that the distances-of-default calculated for German major banks, *Landesbanken*, and International bank holdings are lower as those of the other banking sectors, due to the higher volatility of their profits and losses. By contrast, *Sparkassen* and cooperatives consistently operated their business at higher distances-to-default over the entire period. A similar pattern has developed in the case

of regional banks from 1999 to 2006, but with a significant reduction in the distances-to-default in 2007 to 2008. In addition, Table 10 illustrates the enormous losses suffered by German major banks and *Landesbanken* during 2008 and 2009, and which significantly contributed to the severity of the crisis within the German banking system during the course of the global sub-prime mortgage crisis. Although based only on aggregated data, Table 11 clearly highlights the need for regulatory authorities to pay greater attention to the leverage of banks, as well as their distances-to-default, in crises. Since low distances-to-default, in particular, are evidenced for the duration of the entire observation period, the apparent difficulties of German banks in 2008 and 2009 are no longer surprising. On the contrary, the results of this study emphasize that increased leveraging and diminishing distances-to-default can be useful early warning signs for regulatory authorities and policy-makers as suggested, for instance, by D`Hulster (2009).

Table 10: Return on assets of banking sectors from 1999 to 2010
This table reports the return on assets (ROA) of different German banking sectors from 1999 to 2010. (GB=German major bank, RB=regional bank, LB=Landesbank, SPK= Sparkassen, GEN=cooperatives, AB=International bank holding).

Year	Total	GB	RB	LB	SPK	GEN	AB
1999	0.20	0.20	0.45	0.13	0.24	0.21	0.15
2000	0.19	0.24	0.30	0.10	0.25	0.19	0.57
2001	0.20	0.18	0.18	0.11	0.38	0.35	0.22
2002	0.15	-0.12	0.41	0.08	0.35	0.46	0.28
2003	-0.05	-0.44	0.11	-0.17	0.18	0.26	0.10
2004	0.07	-0.10	0.11	-0.02	0.23	0.27	0.10
2005	0.31	0.56	0.31	0.17	0.27	0.47	0.21
2006	0.29	0.33	0.27	0.31	0.24	0.47	0.23
2007	0.18	0.57	0.36	0.03	0.21	0.30	1.17
2008	-0.32	-0.76	0.10	-0.39	0.11	0.23	-0.29
2009	-0.08	-0.31	-0.06	-0.34	0.23	0.28	0.10
2010	0.20	0.20	0.45	0.13	0.24	0.21	0.15

Table 11: Distances-to-default of German banking sectors from 1996 to 2010
This table shows the distances-to-default (DD) of different German banking sectors from 2001 to 2010. (GB=German major bank, RB=regional bank, LB=Landesbank, SPK=Sparkassen, GEN=cooperatives, AB=International bank holding).

Year	Total	GB	RB	LB	SPK	GEN	AB
1999	1.42	0.67	3.17	0.88	3.94	2.57	0.57
2000	1.35	0.77	2.22	0.71	4.04	2.39	1.75
2001	1.43	0.62	1.47	0.80	5.93	3.96	0.75
2002	1.15	-0.14	2.92	0.67	5.54	5.06	0.92
2003	-0.03	-0.98	1.04	-0.64	3.17	3.10	0.39
2004	0.66	-0.15	1.07	0.12	3.89	3.21	0.39
2005	2.09	1.52	2.36	1.12	4.47	5.20	0.72
2006	1.97	0.95	2.09	1.84	4.08	5.23	0.77
2007	1.33	1.55	2.64	0.37	3.68	3.56	3.49
2008	-1.60	-1.78	0.92	-1.81	2.29	2.85	-0.70
2009	-0.18	-0.65	-0.04	-1.51	3.98	3.34	0.45
2010	1.15	0.31	0.80	-0.03	6.10	5.04	0.81

4. Conclusion

The results of my study as presented above prove that the elements of the German banking system did operate their business on a pro-cyclical basis, and that pro-cyclicality was sector-dependent. Within this context pro-cyclicality do not relate to general economic conditions but is characterized by high actively adjusting leverages of banks during period of booming asset markets. German major banks and *Landesbanken* have been shown to increase their leverage during periods of booming asset markets, whereas cooperatives and *Sparkassen* indicated a reduction in their leverage during the same period. These findings coincide with the distinguishable business models of the German banking sectors.

My study also provides some empirical evidence that banks that increased their leverages during periods of extraordinarily asset growth also tended to refinance their assets through short-term borrowing in the interbank market, whereas other sectors such as *Sparkassen* or cooperatives relied on non-bank refinancing to a higher degree. These refinancing patterns caused severe liquidity shortages of banks that had largely refunded their assets in the interbank market, because the tensions of the financial markets in 2007/2008 resulted in an increasing distrust in the interbank market.[12]

Moreover, my study confirms that throughout the observation period banks, which chose high leverages also, report a high volatility of return on assets, thus providing an

[12] Abassi and Schnabel (2009), for example, examine contagion effects in the interbank market during the sub-prime mortgage crisis in 2007/2008.

indirect measurement of risk-taking behavior.[13] Both the high leveraging of corresponding balance sheet operations, and the high dispersion of returns on assets have been shown to be the cause of low distances-to-default, and these can reflects the vulnerability of such banks during crisis periods, as the sub-prime mortgage crisis in 2007/2008 has illustrated.

From the perspective of regulatory authorities, such risk-friendly behavior suggests the need for the introduction of a reasonable counter-cyclical capital buffer.[14] In real terms, this would mean that banks could be compelled to reduce their leverage ratios during periods of excessive credit growth in order to prevent high losses when asset prices are significantly turning down as suggested, for example, by D`Hulster (2009).

[13] See for example Barry et al. (2008).
[14] A counter-cyclical capital buffer is part of the 'International regulatory framework for banks - Basel III' (see Bank for International Settlements [2011]).

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Are private banks the better banks?
An insight into the principal-agent structure and risk-taking behavior of German banks.

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Abstract

In this study, we propose our hypothesis that the distinguishable principal-agent relationships of German banks are significantly influencing the risk-taking attitudes of bank managers. Particularly, we intend to substantiate the theory that banks owned by dispersed shareholders or federal state authorities face a higher relevance of principal-agent problems than other banking sectors due to a missing ability to monitor bank managers. Our results underline that these problems appear to mislead bank managers showing an unreasonable risk-taking behavior. In a first stage, we rely on a theoretical model explaining that from the bank owners' viewpoint three factors of the principal-agent relationships are determining the probability of choosing the optimal portfolio of risky assets. These factors cover the ability to control bank managers, the risk pooling capabilities of bank owners and bank managers, and the incentives of seeking high returns. To support our hypothesis we apply an empirical study to the distances-to-default of different German banking sectors. This demonstrates that risk-taking attitudes of banks are closely related to banks' ownership. Consequently, our findings offer evidence, that legislative and regulatory authorities should increase their vigilance in terms of principal-agent problems within certain sectors of the banking industry.

JEL Classification Numbers: G01, G12, G14, G28, G15, G32

Keywords: Financial crises; risk-taking behavior; risk aversion; efficient portfolios; information asymmetries and market efficiency; government policy and regulation; risk pooling; seeking for high returns; monitoring capabilities; capital and ownership structure; distance-to-default; capital asset ratio; return on assets

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1. Introduction

Our paper intends to examine whether multistage principal-agent relationships are explaining the different risk-taking behavior of German banks in the course of the financial crisis from 2007 to 2008. Within this context, it appears reasonable to distinguish between banks with dispersed shareholders and banks with a high ownership concentration.[3] The classical principal-agent theory assumes that managers pursue different objectives and show different risk-taking attitudes than firms' owners. Amihud and Levy (1981) or Hirshleifer and Thakor (1992), for example, argue that managers generally avoid risk-taking due to career concerns. Accordingly, managers show a more averse risk-taking behavior than firms` owners, because they are not able to diversify their unemployment risk.

By contrast to managers, dispersed shareholders have larger incentives to behave risk-neutral (Jensen and Meckling [1976], Demsetz and Lehn [1985], Esty [1998]), because they are capable to diversify their risk by engaging in a large number of projects. Furthermore, dispersed shareholders obtain lower incentives to control managers because they have to share the benefits of controlling activities with other shareholders irrespective of their capability to control. Thus, large shareholders are able to overcome this incentive problem, and therefore attain a higher chance to prevent low risk-taking by managers (Morck et al. [2005], Stultz [2005]). Our paper contributes to this discussion by modelling the theoretical background of principal-agent problems in the banking industry taking into account the probability of their occurrence depending on different types of banks. Moreover, our study offers empirical evidence of a distinguishable risk-taking behavior of German banks that relates to the ownership structure and monitoring capabilities of different banking sectors.

Taking into account the ambiguous effects of the shareholder structure on risk-taking behavior of banks as considered by Stultz (2005), Beck et al. (2009), and Barry et al. (2011) a number of recent studies are clearly distinguishing between shareholder concentration and shareholder rights to explain the influences of the shareholder structure on risk-taking attitudes of bank managers. Gropp and Köhler (2010) have reported that shareholders prefer more risk compared to managers irrespective of whether using shareholder rights or ownership concentration as a measurement of owner control. Moreover, Gropp and Köhler argue that bank managers generally prefer a less exposure to risk compared to owners, whether dispersed or not. Thus, their hypothesis is contradictory to some policy reports assuming that extremely generous performance based compensations obtained by poor controlled bank managers are leading to extremely risk-taking by bank managers (Kirkpatrick

[3]Caprio et al. (2007) classify a bank having an influencing owner if the shareholder has voting rights of more than 10%.

[2009]). Laeven and Levine (2009) also underscore that the relationship between banks' risks and capital regulation depends critically on the ownership structure of a bank and therefore have important policy implications.[4] In general terms, these authors offer empirical evidence that risk-taking by banks positively correlates with the comparative power of shareholders. This hypothesis coincides with the results provided by Saunders et al. (1990) suggesting that owner-controlled banks enter into higher risks than banks controlled by managers with small shareholdings. Furthermore, Beck et al. (2009) provide evidence that larger privately held banks move closer to insolvency than the smaller peers, but face lower distress probability. Moreover, Beck et al. show that within the German banking industry, privately owned banks are less stable than savings banks or cooperatives whereas they describe savings banks as reporting greater distances-to-default than cooperatives. This view is consistent with Fonteyne (2007) who highlight that cooperative banks in Europe are engaging in less risky activities than commercial banks (see also Cihák and Hesse [2007]).

Barry et al. (2009) have found some contradictory results by comparing five categories of shareholders that are managers/directors, institutional investors, non-financial companies, individuals/families, and banks. Barry et al. demonstrate that the ownership structure is evidently explaining differences in risk exposures of privately owned banks. Accordingly, high equity stakes held by individuals/families or banking institutions correlate with a decrease in asset risk and default risk. These findings confirm results published by Iannotta et al. (2007) who demonstrate that a higher ownership concentration is associated with better loan quality, lower asset risk, and lower insolvency risk.[5] De Nicolò and Loukoianova (2007) indicate that due to the country and firm specific characteristics the risk exposure of foreign banks appears significantly higher than that reported for private domestic banks. Nevertheless, De Nicolò and Loukoianova are not able to maintain their findings in the case of state-owned banks and private domestic banks. In addition, the authors verify that private domestic banks enter to more risk than state-owned or foreign banks due to the larger market share of state-owned or foreign banks. By contrast, Barry et al. (2009) have not been able to find a significant relationship between ownership structure and risk-taking attitudes in the category of public banks. Moreover, they do not report a significant difference between publicly held and privately owned banks while Berger et al. (2005) demonstrate state-owned banks

[4]Leaven and Levine (2009) argue that owners might compensate for the loss of utility from capital requirements by selecting riskier investment strategies. Thus, it seems likely that stricter capital regulations and banking regulation correlate with greater risk when the bank has a sufficiently powerful owner.

[5] Iannotta et al. (2007) have found some empirical evidence that public sector banks have poorer loan quality and higher insolvency risk than other banks. Furthermore, their results indicate that mutual banks (saving banks and cooperatives) rely on better loan quality and lower asset risk than both private and public sector banks.

reporting poorer loan quality and higher default risk than privately owned banks. Another strain of papers also differentiate between categories of risks by showing that mutual banks enter to lower asset risk and lower default risk than government owned banks (Fraser and Zardkoohi [1996], Hansmann [1996]), Esty [1997], and Iannotta et al. [2007]).

Finally, Kwan (2004) illustrates that the exposure to risk of publicly held and privately owned banks are statistically indistinguishable when considering US bank holding companies. This is consistent with Altunbas et al. (2001) who indicate only a low significance of their findings in the German banking system that privately owned banks are operating their business more efficiently than mutual and publicly held banks. Furthermore, Beltratti and Stultz (2009) have studied the influence of bank-level governance, country-level governance, country-level regulation, and banks' balance sheet and profitability characteristics on banks' performance in the course of the financial crisis from 2007 to 2008. In accordance with the ownership structure of banks, Beltratti and Stultz underline that there is no consistent evidence that better governance lead to better performance during the crisis, but have found strong evidence that those banks with more shareholder-friendly boards perform worse.

A considerable amount of research works indicates a significant relationship between ownership concentration and risk-taking. Nevertheless, there is apparently no consensus whether this relationship is positive or negative (Iannotta et al. [2007], Barry et al. [2009]). These ambiguous results in recent literature may be occurring because besides the ownership concentration a number of further conditions are also determining the risk-taking attitudes of bank managers and bank owners. These are, for instance, the role of banking regulation (Macey and O`Hara [2003], Levine [2004], Laeven and Levine [2009]), deposit insurance (Prowse [1997], Beck and Laeven [2008]), or the globalization of the banking industry (Pathan [2009]). Furthermore, bank market concentration (Boyd and De Nicoló [2005], De Nicolò and Loukoianova [2007]), stock ownership programs, and annual compensation schemes for bank managers (Erkens et al. [2009], Bebchuk and Spamann [2010]), and the strength of bank boards (Sullivan and Spong [2007]) seem to relate to banks' risk-taking attitudes. Moreover, general macroeconomic circumstances appear to influence the risk-taking behavior of banks.[6][7]

In this study, we intend to prove our hypothesis that it depends on the relevance of principal-agent problems whether a bank is willing to enter to substantial risks or not.

[6]Erkens et al. (2009) have shown that banks applying CEO compensation contracts with heavier emphasis on annual bonuses were faced larger losses during the financial crisis from 2007 to 2009. Bebchuk and Spamann (2010) suggest using regulation of banks' executive pay as an important element of financial regulation because they show a significant relationship between banks' executive pay and risk-taking behavior of banks' executives.
[7] Boyd and De Nicoló (2005) argue that banks behave more risky as their markets become more concentrated.

Particularly, banking sectors appear to be vulnerable to risks that do not allow bank owners monitoring bank managers. Furthermore, risk attitudes of banks depend on the capability of bank owners and bank managers to distribute risks on several firms. Finally, we intend to argue that the bank owners' incentives for gaining high returns strongly influence banks' risk taking behavior. Bank managers strongly depending on high profit-motivated principals (capital market oriented or profit-seeking public owners) to a high degree tend to operate their business by strategies that emphasize above average returns without looking at risks. Therefore, we use several aspects of the principal-agent model to predict bank managers' risk-taking behavior. Moreover, we apply an empirical study to the distances-to-default of different German banking sectors to enlighten banks' risk-taking attitudes prior to, and during the financial crisis of 2008.[8]

In section 2, following, we will start outlining the theoretical background to gain ideas whether it is possible that bank managers deviate from the expected return to risk relation that bank owners prefer. Section 3 will summarize the data with a focus on explaining the different ownership structures of German banks. Section 4 will compile the results and assess those results within the scope of our proposed hypothesis. The paper will close with section 5 with a summary and a conclusion of our findings.

2. Theoretical Backgrounds

As pointed out before, the basic hypothesis of our paper is grounded on the assumption that the default probability of a bank measured by the distance-to-default depends on the bank's ownership structure and corresponding property rights structure. Accordingly, we will argue, that in the case of decreasing influence of bank owners on the behavior of the bank's employees, the occurrence of principal-agent problems is more likely.[9]

The basic principal-agent theory (see for example Cullis and Jones [2009], pp. 255-6) applied to the organizational structure of a bank suggests that the principal (bank owner) *P* mandates an employee as his agent *A* to do bank operations. The agent *A* is free how to do these operations, but has to accept given restrictions. In the case of banks, agents have to choose a portfolio that consists of more or less risky assets. Thus, the behavior of *A* is influencing principal's profit $E(r_p)$. If the agent is using more effort *e* in her operations, she has to bear higher costs whereas from the principal's viewpoint executing more effort by the agent is a neutral good.

[8] We define distances-to-default as the ratio of the sum of capital-asset-ratio (CAR) and return-on-assets (ROA) to standard deviation of return-on-assets (σ [ROA]). See for example Boyd and Graham (1986).
[9] See for example Saunders et al. (1990), Stultz (2005), Beck et al. (2009) and Barry et al. (2009)

Typically, the bank owner offers a contract regulating the working conditions for the potential employee, including commitments on fixed salaries, variable salaries (rewards), and fringe benefits. Depending on alternative employing opportunities, *A* decides to enter or not to enter the firm. If she is in the bank, she will be able to decide on her level of effort, for example, on the amount of collecting information prior to making investment decisions and choosing the optimal portfolio of assets. Unforeseeable market conditions or chance θ (state of nature) also influence return on assets. Depending on e and θ the bank will receive returns that owners and employees have to share according with the commitments agreed by both parties in the initial offer.

We will adopt a very simple Holmström/Milgrom principal-agent model to demonstrate the relationship between risk aversion of agents and their risk-taking attitudes under uncertainty. This model grounds on a risk neutral principal *P* who employs a risk averse or risk neutral agent *A* with a coefficient of risk aversion *F*.[10] In addition to the classic principal-agent model, our model assumes that the agent is free to choose any combination of risky and less risky projects (assets), whereas an efficient frontier as suggested by Markowitz (1952) is characterizing combinations of risky and less risky assets. Moreover, the agent supposes a probability function of possible returns and risk over different holding periods assuming that financial markets are frictionless. Agents obey a single-period utility functions *U*, which will be maximized in accordance with the law of diminishing marginal utility of wealth. The principal supposes that agent's effort increases the likelihood of choosing the optimal portfolio. If the agent's effort is generally not observable or it is costly for the principal to monitor the agent, the principal (bank owner) has to use incentives to encourage the agent selecting the owner's optimal portfolio.

We will use a commonly accepted utility function to illustrate the relationship between risk aversion of the agent and her risk-taking behavior that may depend on incentives paid by a risk neutral principal

$$U = E(r_p) - 0.005F\sigma_p^2,$$

whereas *F* characterizes the agent's risk aversion factor (for further information see Sharpe [2007].) In the case of risk-neutral agents, *F=0*. Larger values for *F* are reflecting higher degrees of risk aversion. The agent's optimal portfolio is the one that provides the highest utility for the agent. This portfolio will be at the tangent of the respective indifference curve and the efficient frontier (Markowitz [1952]).

[10]See for example Sinclair-Desagné and Spaeter (2011) who developed a model describing behavior of prudent principals

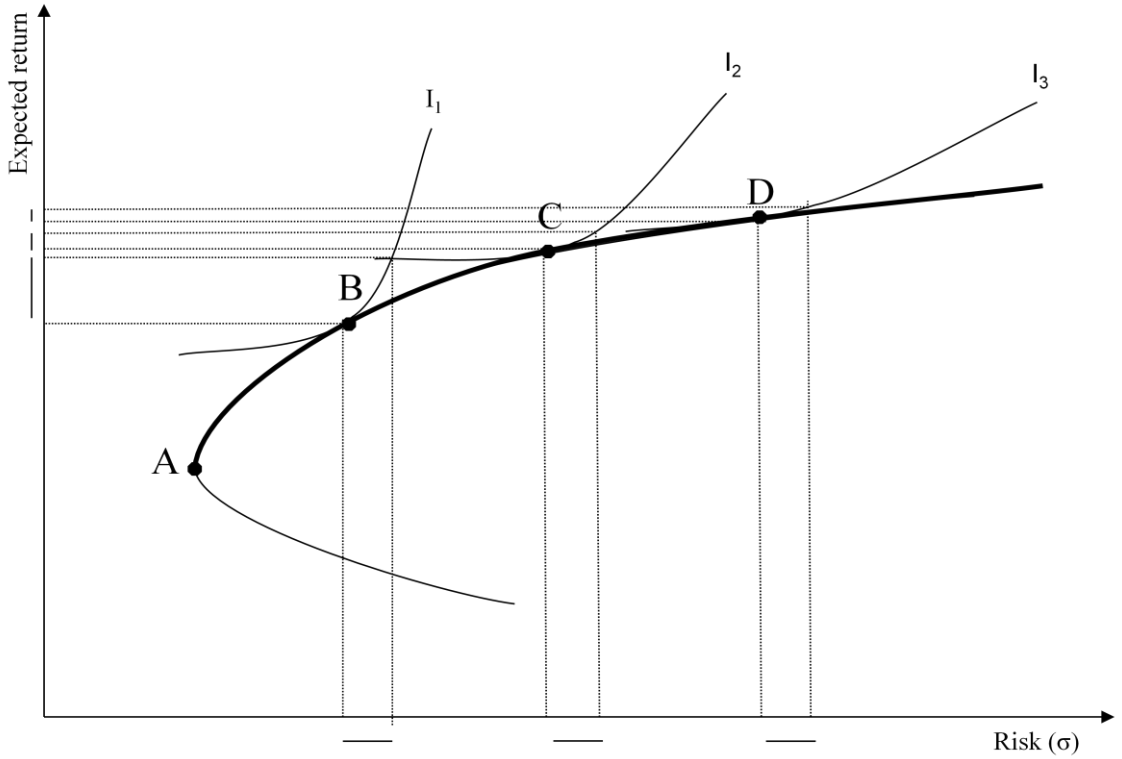
Figure 1 explains the relationship between expected returns and risk. Point A and points in the northeast of A like B, C, and D are efficient in the sense of Markowitz. Indifference curves I_1 to I_3 represent risk averse individuals, whereas I_1 is the indifference curve of a more risk averse individual. Moreover, we characterize I_2 and I_3 as modest and low risk averse individuals.

The degree of risk aversion becomes clearer, if we assume B, C, or D as starting points and alternatively consider for the tradeoff between the return that an individual have to receive and a given value of additional risk exposure (expected utility is assumed constant). The additional expected returns are decreasing if we move from B to D. Thus, a decreasing curvature of indifference curve indicates a decreasing risk aversion. Within this frame, we argue that bank owners will prefer point C if they are modest risk averse. Grounded on the basic principal-agent theory, bank managers are more risk averse than bank owners because they have lower possibilities of risk pooling. Managers are realizing less risk than owners, for instance, by choosing point B. If bank managers have alternative job opportunities in other firms, it becomes more likely that they engage in excessively risky activities, and may prefer point D. Both deviations from the preferred point C are restricted by the owners' ability to control the bank managers.

Risk attitudes of bank owners may also relate to multistage principal-agent relationships. If we presume a sole owner, she is free to choose her combination of risk and expected return depending on her preferences, point B in figure 1 may be optimal. Principals of bank managers are typically the 'boards of banks'. Highly profit-oriented capital markets frequently force the boards of banks mandated by their shareholders to seek point C in figure 1. In the case of state owned banks, the principals (politicians) may also be looking for above average returns to finance public expenses outside of public budgets so that we suppose bank owners choosing Point C as well. Moreover, often the owner of a bank is simultaneously operating as the agent on behalf of another private firm (e.g. International bank holdings or insurance companies), the citizens of a region (local communities), or the cooperative members of the bank (cooperatives) so that we frequently observe multistage principal-agent relationships. Due to these more complex ownership structures, the preferred combination of risk and expected return is tied to an increasing relevance of the principal-agent problems.

All the above conditions explain why from the bank owner's viewpoint the selection of optimal portfolios of risky assets will be most unlikely with the emergence of multistage principal-agent relationships because higher information asymmetries between bank owners and bank managers are additionally increasing the probability of principal-agents problems.

Figure 1: Indifference curves of principal and agents



As stated out before, because of such uncertainties and information asymmetries we propose a (significantly) higher probability of a firm-specific financial crisis that is measured, for instance, by distances-to-default. Moreover, the probability of default is depending on the degree of pressure on bank managers exerted by bank owners to seek higher returns.

3. Data and assessment of different ownership structures

The Bankscope Database has provided the data, on which this study is based, for the period 2000 to 2010. Our panel involves 397 banks assigned to ten different principal-agent relationships, while we have collected the information on the principal-ownership structures manually from banks' annual reports published in 2008. Furthermore, we have marked all banks in our database traded on a stock exchange in 2008 and have discarded all banks from our sample if we did not get the relevant information for the years 2007 and 2008. Annual observations have entered our sample only if we get the complete information on 'return-on-assets', 'common equity' and 'total assets' for the corresponding year of examination. After eliminating discarded data sets our final sample covers 3,194 annual observations.[11]

In order to prepare the ground for our study we are first of all showing a number of descriptive statistics. Furthermore, we shall apply a number of least square regressions on the so-called z-score (distance-to-default) described, for example, in Boyd and Graham's seminal

[11] Bankscope database, Bureau van Dijk Electronic Publishing

paper of 1986 as an appropriate measure of a bank's probability of default. The distances-to-default (DD) will be calculated from the 'return-on-assets' (ROA), the ratio of 'common equity' to 'total assets' (CAR) and the standard deviation of 'return-on-assets' (σROA):

$$DD = \frac{CAR+ROA}{\sigma ROA}\text{, whereas } ROA = \frac{return}{total\ assets} \text{ and } CAR = \frac{common\ equity}{total\ assets}.$$

Thus, the somewhat intuitive z-score estimates the number of standard deviations the annual return-on-assets figures could fall, before the common equity of a bank turns negative. We will compute this risk figure grounded on the standard deviation (σROA) of each corresponding banking sector (see Table 13). Besides the higher validity of these distances-to-default, a further advantage of computing sector specific standard deviations of the return on assets is the comparability of banks that are reporting similar business objectives.

In the section, following, we will use three commonly influencing factors of the principal-agent relationship on banks' risk taking behavior in order to illustrate the emergence of principal-agent problems within the different ownership structures.

If bank owners have the *ability to control bank managers* sufficiently, we do not expect that the bank managers deviate from the optimal investment portfolio. Thus, principal-agent problems do not seem likely. Accordingly, Table 1 displays our estimations of the monitoring capabilities within the distinguishable banking categories.

We tend to characterize *Landesbanken* by low abilities of owners to control bank managers because the politicians who are conducting governance issues instead of the factual owners ('citizens') are typically uninformed about the banking business. Local politicians mandated by the citizens to monitor savings banks are also constrained by missing knowledge about the banking business.

In case of dispersed shareholders, we traditionally assume that shareholders have no control incentives because they have to share the benefits of monitoring to all other shareholders. Thus, regarding monitoring capabilities we assume a high relevance of principal-agent problems for banks held by dispersed shareholders. By contrast, banks owned by only one individual (or 'family') are subject to high control incentives. The risk-taking behavior of banks affiliated with commercial banks *(commercial banks)* depends on their specific ownership structure. If one individual or family owns a *commercial bank*, we expect the owner to have a considerable incentive to control. If dispersed shareholders are owners of a *commercial bank*, we contrarily do not presume a sufficient monitoring by bank owners. Hence, for *commercial banks* we suppose a medium relevance of principal-agent problems.

Taking into account federal state authority's banks with special business purposes owned by the federal states, we suppose that the governments and namely the ministries of finance are able to control the bank managers to a high degree. By contrast, members of cooperatives generally are not able to monitor the bank managers. Finally, we assess controlling abilities of banks affiliated with insurance companies or International bank holdings to be comparable to those of *commercial banks*.

Table 1: This table shows our assessment of capability of bank owners to monitor bank managers and relevance of principal-agent problems assigned to the distinguishable ownership structures.

Ownership structure	Capability	Relevance of principal-agent problems
Federal state authorities (Landesbanken)	Low	High
Local communities (savings banks)	Low	High
Private owner	High	Low
Dispersed shareholders	Low	High
Commercial bank		
– Private owner – Dispersed shareholders	High Low	Medium
Cooperatives	Low	High
Insurance Companies		
– Private owner – Dispersed shareholders	High Low	Medium
International bank holdings		
– Private owner – Dispersed shareholders	High Low	Medium

The theoretical background on *risk pooling by bank owners or bank managers* explain that the bank owners appear to be risk neutral or less risk averse than bank managers if owners have better pooling possibilities (pp). Therefore, bank owners prefer higher risk than bank managers do. By contrast, if bank manager do not fear to lose their workplace (wp) they are seeking unreasonable high risks. In this case, bank managers prefer higher risks than the owners do and principal-agent problems are more likely. More generally speaking, we assume that throughout the years prior to the financial crisis of 2007/2008 investment bankers faced low risk of loosing their workplace. Both high pooling possibilities of bank owners and low risk of bank managers of losing their workplace lead to seeking high risk by banks.

In the case of banks owned by federal state authorities (*Landesbanken*), we do not notice a chance of risk pooling by bank owners ('citizens'). By contrast, we presume that *Landesbanken* engaged investment bankers that have incentives to seek unreasonably high risk. Thus, both the missing capability of risk pooling and the engagement of investment bankers correlate with a high relevance of principal-agent problems.

Owners of savings banks ('local communities') and cooperatives are also very restricted in risk pooling. In addition, savings banks and cooperatives typically do not engage investment

bankers. Therefore, we expect low incentives to search for risky activities resulting in a low relevance of principal-agent problems.

By contrast, dispersed shareholders retain good opportunities to diversify their wealth in several firms. Therefore, they are behaving (nearly) risk neutral. Furthermore, banks owned by dispersed shareholders are able to engage investment bankers. Thus, in this case we presume a high relevance of principal-agent problems.

If an individual or family owns a bank, the capacity of risk dispersion usually is limited so that we do not expect a divergence between risk attitudes of bank owners and bank managers. Private banks face also good job opportunities of engaged investment bankers that create excessive risk-taking incentives and causes a high relevance of principal-agent problems. *Commercial banks*, banks affiliated with insurance companies and subsidiaries of International bank holdings are owned either by private owners or by dispersed shareholders. Hence, the relevance of principal-agent problems appears to be medium to high.

Table 2: This table shows our assessment whether bank owners are equal risk averse than bank managers (lower pooling capabilities [pp])) and whether managers have good chances to find a new workplace (wp).

Ownership structure	Yes/ No	Relevance of principal-agent problems
Federal state authorities (Landesbanken)	No (pp), Yes (wp)	High
Local communities (savings banks)	No (pp), No (wp)	Low
Private owner	No (pp), Yes (wp)	High
Dispersed shareholders	Yes (pp), Yes (wp)	High
Commercial bank		
– Private owner – Dispersed shareholders	No (pp), Yes (wp) Yes (pp), Yes (wp)	Medium to high
Cooperatives	No (pp), No (wp)	Medium
Insurance Companies		
– Private owner – Dispersed shareholders	No (pp), Yes (wp) Yes (pp), Yes (wp)	Medium to high
International bank holdings		
– Private owner – Dispersed shareholders	No (pp), Yes (wp) Yes (pp), Yes (wp)	Medium to high

Incentives of seeking higher returns may be excessive, when banks' operations ground on higher profit-orientated principal-agent relationships. In the case of federal state authorities (*Landesbanken*) we assume that the influence of the principal ('politicians') creates incentives to seek higher returns because of principals' expectation on financing public expenditures out of bank profits while savings banks owned by local communities as well as cooperatives do not seem to be influenced by such incentives. Banks owned by dispersed shareholders appear to be tied to capital market expectations on gaining high returns to a high degree. By contrast, banks with individual owners apparently do not obey this kind of expectation. Thus, dispersed shareholders fortify principal-agent problems while private owners may weaken this issue.

Finally, we suppose that *commercial banks*, banks affiliated with insurance companies and subsidiaries of International bank holdings relate to medium expectations on future returns.

Table 3: This table shows our assessment whether bank owners have incentives of seeking high returns.

Ownership structure	Yes/ No	Relevance of principal-agent problems
Federal state authorities (Landesbanken)	Yes	High
Local communities (savings banks)	No	Low
Private owner	No	Low
Dispersed shareholders	Yes	High
Commercial bank		
– Private owner – Dispersed shareholders	No Yes	Medium
Cooperatives	No	Low
Insurance Companies		
– Private owner – Dispersed shareholders	No Yes	Medium
International bank holdings		
– Private owner – Dispersed shareholders	No Yes	Medium

Table 4 summarizes the *aggregated relevance of principal-agent problems* emerging from the factors mentioned above while we assume that all these factors show an equal impact on the risk-taking attitudes of banks. Thus, we apparently find the highest relevance of principal-agent problems in the case of federal state authorities (*Landesbanken*) and banks owned by dispersed shareholders while we predict a low relevance for local communities as well as private banks and medium-scale relevance in the case of other bank categories.

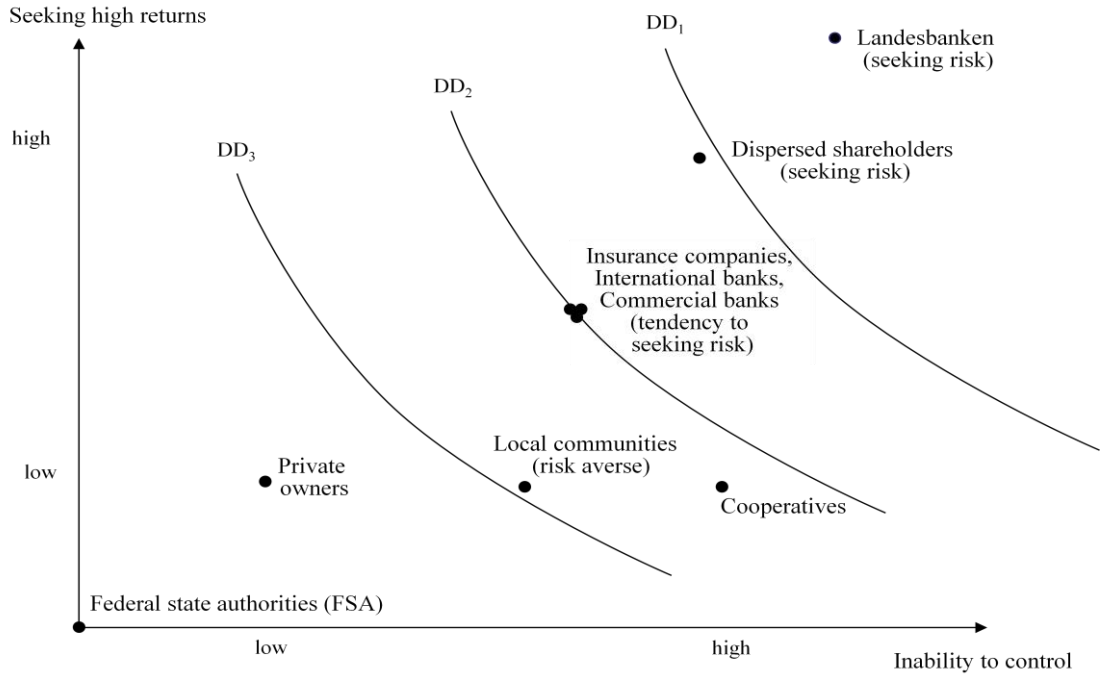
Table 4: This Table aggregates the relevance of principal-agent problems displayed in Table 1 to Table 3

	Monitoring Capabilities	Risk Aversion	Seeking High Returns	Aggregation
Federal state authorities (Landesbanken)	High	High	High	High
Local communities (savings banks)	High	Low	Low	Low to medium
Private owner	Low	High	Low	Low
Dispersed shareholders	High	High	High	High
Commercial bank	Medium	Medium to high	Medium	Medium
Cooperatives	High	Medium	Low	Low
Insurance companies	Medium	Medium to high	Medium	Medium
International bank holdings	Medium	Medium to high	Medium	Medium

Accordingly, Figure 2 shows the importance of the principal-agent problems graphically. We draw simplified curves of equal distances-to-default, for example DD_1 to DD_3. Curves that are closer to the origin indicate higher distances-to-default. Consequently, we expect the highest

distances-to-default for banks owned by an individual owner and the lowest ones for federal state authorities *(Landesbanken).*

Figure 2: This figure illustrates the distances-of-default of different ownership-structures



It seems reasonable to compare distinguishable categories of bank with credit institutions owned by federal state authorities', like Kreditanstalt für Wiederaufbau' (KfW Bankengruppe) that special purposes are centered exclusively on the financing of private firms. Hence, for these institutions aspects like risk-taking or capital market pressure are irrelevant. We additionally assume that the government uses appropriate instruments to control the behavior of such special-purpose banks. Therefore, we expect federal state authorities in the origin of figure 2.

4. Analysis and Results

The following section covers our descriptive statistics and regression models applied to enlighten the influence of ownership structures on risk-taking attitudes of banks with a focus on the subprime crisis of 2008.

First, Table 6 shows the 'capital asset ratio' (CAR) assigned to the different ownership categories throughout the observation period. We can ascertain that special purpose banks owned by federal authorities report the highest capital asset ratios. By contrast, *Landesbanken* display the lowest capital asset ratio, which may be due the fact that these banks are also controlled by federal authorities, but have adopted a completely different business model as described by Hüfner (2010) or Hardy and Howarth (2009). Furthermore, private banks,

subsidiaries of insurance companies, and banks affiliated with cooperatives are distinguishable by relatively low capital asset ratios while banks monitored by dispersed shareholders or International bank holdings apparently prefer higher capitalizations. Not surprisingly, savings banks and cooperatives display similar capital asset ratios over the examination period that may be due to their comparative business models (Beck et al. [2009]). As pointed out by Adrian and Shin (2010), Brunnermeier (2009), or Schmielewski (2012), low capital asset ratios by banks may indicate a low risk aversion throughout periods of booming asset markets particularly if banks are simultaneously reporting high leverages and a high volatility of 'return on assets' (ROA).

Table 6: Capital Asset Ratio (CAR) by principal
This table shows the Capital Asset Ratio (CAR) grouped by the examined ownership structures (principal) over the period 2001 to 2009. The Capital Asset Ratio (CAR) is the ratio of common equity to total assets. The sample contains 3,194 yearly observations from 397 banks. For further details of sample structure, see section 'data'.

Principal	Average	Median	Max	Min	Avg. quantiles
Federal state authorities	0.1695	0.5068	0.9911	0.0226	0.61
Dispersed shareholders	0.0934	0.3967	0.7971	- 0.0036	0.49
International bank holdings	0.0738	0.3775	0.7515	0.0036	0.48
Local communities (savings banks)	0.0517	0.2789	0.5490	0.0088	0.52
Member of cooperatives	0.0516	0.2745	0.5411	0.0078	0.49
Commercial bank	0.0491	0.1101	0.2177	0.0025	0.36
Private	0.0597	0.0771	0.1526	0.0015	0.59
Insurance company	0.0443	0.0475	0.0741	0.0210	0.42
Cooperatives	0.0370	0.0419	0.0744	0.0095	0.33
Federal state authorities (Landesbanken)	0.0223	0.0240	0.0415	0.0064	0.06

Table 7 reports 'return on assets' (ROA) of banks tied to the different ownership structures over the observation period. Within this context, it is remarkable that some *Landesbanken* that are reporting the lowest returns on assets have been among the crisis-ridden banks that the Financial Markets Stabilization Fund (SoFFin) has to support in the aftermath of the financial markets crisis of 2007/2008 to a high degree. This fact may be due to their changing business environment over the last decade, as pointed out, for example, by Hardy and Howarth (2009) or Hüfner (2010). By contrast, cooperatives, banks controlled by dispersed shareholders, and subsidiaries of International bank holdings demonstrate the highest returns on assets from 2000 to 2009, while savings banks and affiliates of cooperatives are reporting relatively low returns on assets.

Table 7: Return on Assets (ROA) by principal

This table reports the Return on Assets (ROA) grouped by the examined ownership structures (principal) over the period 2001 to 2009. We define Return on Assets (ROA) as the ratio of yearly return on total assets. The sample contains 3,194 yearly observations from 397 banks.

Principal	Average	Median	Max	Min	Avg. quantiles
Member of cooperatives	0.0029	0.0955	0.1918	-0.0007	0.47
Dispersed shareholders	-0.0003	0.0486	0.0975	-0.0004	0.44
International bank holdings	0.0038	0.0482	0.0967	-0.0002	0.44
Federal state authorities	0.0030	0.0284	0.0578	-0.0010	0.34
Private	0.0038	0.0124	0.0284	-0.0036	0.58
Commercial bank	-0.0004	0.0095	0.0195	-0.0004	0.56
Insurance company	0.0028	0.0076	0.0153	-0.0001	0.50
Cooperatives	0.0015	0.0046	0.0092	0.0000	0.30
Local communities (savings banks)	0.0016	0.0045	0.0092	-0.0001	0.43
Federal state authorities (Landesbanken)	-0.0001	0.0024	0.0050	-0.0002	0.56

However, returns on assets are only a rough indicator on the risk appetite of banks. By contrast, the ‘distance-to-default’ (DD) or so-called ‘z-score’ that is described in detail in section 3 is a widely accepted and intuitive risk figure because it takes into account the volatility of returns on assets. Table 8 demonstrates that special purpose banks owned by federal authorities will apparently be the most risk averse banks with a distance-to-default of more than five times higher when compared with banks assigned to other ownership categories. We tend to explain this observation by the very special business purposes of such banks that are focused primarily on project financing activities. Quite the opposite, banks monitored by dispersed shareholders, banks affiliated with commercial banks, subsidiaries of International bank holdings as well as *Landesbanken* are evidently reporting the lowest distances-to-default during the period 2000 to 2009. As pointed out before, we are able to typify these kinds of ownership structures by multistage-principal-agent relationships with only weak opportunities to monitor bank managers that may explain their low risk aversion as demonstrated by the according low distances-to-default.

In addition, it is interesting to note that the distances-to-default of cooperatives are relatively low. We tend to explain this observation by relatively strong fluctuations of the returns on assets during the observation period. Contrarily, private banks, banks allied to cooperatives, and subsidiaries of insurance companies are reporting the highest distances-to-default due to the low volatility of return on assets of these banks throughout the examination period in question.

Table 8: Distance-to-default (DD) by principal
This table shows the distance-to-default (DD) grouped by the examined ownership structures (principal) over the period 2001 to 2009. The distance-to-default (DD) equals DD=CAR+ROA/σ (ROA), where σ (ROA) is the standard deviation of ROA. The sample contains 3,194 yearly observations from 397 banks.

Principal	Average	Median	Max	Min	Avg. quantiles
Federal state authorities	19.2752	54.9863	99.3889	10.5838	0.55
Cooperatives	14.6764	9.9157	9.4713	10.3601	0.77
Insurance company	15.9971	9.9104	9.5967	10.2242	0.90
Member of cooperatives	5.4461	5.3732	9.9210	0.8253	0.29
Private	11.8148	5.0530	9.8265	0.2795	0.76
Local communities (savings banks)	8.2962	4.4765	9.9962	-1.0432	0.62
International bank holdings	6.6964	4.2411	9.5652	-1.0830	0.32
Federal state authorities (Landesbanken)	5.5064	4.1766	9.7770	-1.4237	0.34
Commercial bank	4.2783	3.7843	8.5003	-0.9318	0.21
Dispersed shareholders	3.3992	3.4526	7.5120	-0.6068	0.14

Table 9 reports the 'total assets' over the observation period assigned to the different ownership structures. Column 4 shows that the banks owned by dispersed shareholders, savings banks, subsidiaries of commercial banks and *Landesbanken* hold the majority of total assets allocated to the German banking system. Accordingly, the listed values of total assets demonstrate the important role of savings banks and particularly *Landesbanken* within the German financial industry. Furthermore, Table 9 illustrates that in accordance with their total assets savings banks and cooperatives may be of key importance for the stability of the German banking system. In contrast, we are able to characterize private banks and affiliates of insurance companies by relatively low amounts of total assets from 2000 to 2009.

However, our results so far draw a relative rough picture of the relationship between market shares of German banking sectors and risk-taking attitudes of banks during the last decade. Thus, in the following sections, we will offer a deeper insight to the structure of the German banking systems by considering pro-cyclical changes of distances-to-default prior to, and during the financial crisis of 2007/2008 in more detail (Adrian and Shin [2010] or Schmielewski [2012]).

Table 9: Total Assets by principal
This table shows the Total Assets in thousands of Euro grouped by the examined ownership structures (principal) over the period 2001 to 2009. The sample contains 3,194 yearly observations from 397 banks.

	Average	STD. Dev.	Median	Total
Dispersed shareholders	75,310,049	279,993,576	1,073,820,924	12,501,468,147
Local communities (savings banks)	5,604,928	16,663,472	126,147,600	9,881,488,100
Commercial bank	73,986,175	149,746,162	422,138,000	8,952,327,200
Federal state authorities (Landesbanken)	197,825,514	124,029,856	233,269,500	8,704,322,600
International bank holdings	35,535,673	98,577,197	358,345,600	7,711,241,000
Member of cooperatives	10,539,121	68,322,704	512,730,650	6,239,159,600
Federal state authorities	36,796,351	73,083,754	200,092,450	4,157,987,700
Cooperatives	28,383,246	25,017,461	43,805,100	1,419,162,300
Private	3,291,562	2,375,028	5,911,200	306,115,300
Insurance company	3,093,011	1,537,790	2,945,100	108,255,400

Because of substantial losses by German banks and capital asset ratios that are not sufficiently covering an unexpected volatility of return on assets, Table 10 reports a significant decline of distances-to-default in 2008 and 2009. It is interesting to note that the distances-to-default from 2005 to 2007 tend to be significantly increased compared to the period 2001 to 2004. As pointed out before, we are able to highlight the period 2002 to 2008 by increasing averaged values of total assets displayed by German banks. We tend to explain this observation by a large number of banks actively operating their balance sheets to adjust the ratio of total assets to common equity. In the aftermath of the financial turmoil of 2007/2008, banks apparently start de-leveraging their balance sheets by diminishing the assets of the balance sheets as suggested by the averaged value of total assets in 2009 reported in Table 11 (see Schmielewski [2012]).

Table 10: Distances-to-default (DD) from 2001 to 2009
This table shows the distance-to-default (DD) grouped by year over the period 2001 to 2009.The distance-to-default (DD) equals DD=CAR+ROA/σ (ROA) where σ (ROA) is the standard deviation of ROA. The sample contains 3,194 yearly observations from 397 banks.

	Distance-to-default				Quantile Rank
Year	Average	Max	Median	Min	Average
2001	7.4396	93.5773	46.9822	0.3872	0.44
2002	7.2748	95.3766	46.2983	-2.78	0.45
2003	7.8371	96.907	48.6635	0.4201	0.47
2004	7.777	97.3638	48.9642	0.5647	0.49
2005	8.168	97.8812	48.3991	-1.083	0.51
2006	8.3698	98.9628	49.6713	0.3798	0.53
2007	8.4986	99.3889	49.9802	0.5715	0.54
2008	7.5124	9.9354	4.6643	-0.6068	0.51
2009	8.0036	9.9591	5.0827	0.2063	0.54

Table 11: Total Assets from 2001 to 2009
This table shows Total Assets in thousands of Euro grouped by year over the period 2001 to 2009.The sample contains 3.194 yearly observations from 397 banks.

Year	Average	Median	STD. Dev.	Total
2001	8,795,669	49,253,965	2,400,000	2,843,459,600
2002	8,402,511	38,470,427	2,600,000	2,783,116,000
2003	10,245,837	39,487,252	2,800,000	3,447,078,600
2004	11,712,522	41,045,003	3,000,000	4,146,435,500
2005	13,472,913	45,093,730	3,100,000	4,905,714,800
2006	24,165,231	101,704,532	3,200,000	9,278,780,200
2007	28,814,919	127,709,352	3,400,000	11,128,899,900
2008	31,255,892	141,117,481	3,500,000	12,004,791,600
2009	28,857,375	111,876,519	3,700,000	9,371,500,000

At this stage of our study, we have found evidence of the distinguishable risk-taking behavior of various banking sectors by the different ownership structures of German banks. The section, following, will illustrate our results of ordinary least squares regressions applied with the purpose of further clarifying influences on the percentiles of the distance-to-default (DD) for the period 2001 to 2007 and from 2008 to 2009 respectively. In addition, Table 13 relates

distances-to-default to the relevance of principal-agent problems. The independent variables (Table 12) of our regressions cover banks' market share ('market share'), a dummy variable to distinguish between exchange traded and non-exchange traded banks ('exchange traded'), and a factored variable reflecting the ownership structure ('principals') of banks.[12]

Table 12: This Table illustrates our variables used for descriptive statistics and ordinary least square regressions

Variable	Definition	Calculation formula
DD	Distance-to-default	$DD = \frac{CAR + ROA}{\sigma ROA}$ $ROA = \frac{annual\ return}{total\ assets}$ $CAR = \frac{common\ equity}{total\ assets}$ $\sigma ROA = standard\ deviation\ of\ ROA$
QDD (Dependent variable)	Percentile of DD rank within sample	1 = bank with highest DD 0 = bank with lowest DD
market_share	Market share	$market\ share = \frac{total\ assets\ bank}{total\ assets\ industry}$
Exchange traded (dummy variable)	Exchange traded bank	1= yes; 0 = no
Principal agent index (factored variable)	Ownership structure of banks	– Federal state authorities (project financing banks) – Banks with dispersed shareholders – International bank holdings – Private banks (e.g. family owned banks) – Local communities (savings banks) – Cooperatives (banks owned by cooperative members) – Banks owned by commercial banks – Banks owned by insurance companies – Banks owned by cooperatives – Federal state authorities (Landesbanken)

Not surprisingly, the standardized beta coefficients of the assigned ownership structures fluctuate over the period in question to a different extent. The intercepts of the two regression models applied to the period 2001 to 2007 and from 2008 to 2009 respectively demonstrate the significant contraction of distances-to-default within the German banking system during our observation period. Table 13 reports a low relevance of principal-agent problems for cooperatives as well as for the affiliates of cooperatives. Cooperatives obtain negative and

[12] We defined 'Federal state authorities' as the basis of our factored variable

statistically significant standardized beta coefficients, but with higher values from 2008 to 2009 than during the period 2001 to 2007 (Table 14). Compared to special purpose credit institutions owned by federal state authorities, cooperatives generally appear to operate their business activities with relatively low distances-to-default. Nevertheless, the lower coefficients of our regression model for the period 2001 to 2007 in comparison to the period 2008 to 2009 coincides with our assumption that cooperatives report only low principal-agent problems particularly if taking into account the distinguishable intercept of the two regression models. Additionally, the positive and statistically significant coefficients obtained for affiliates of cooperatives evidently confirm this tendency.

Our regression model offers some evidence that *Landesbanken* significantly decrease their distances-to-default from 2008 to 2009, although we only find a statistical significant relationship to the distance-to-default in our regression model for 2008/2009 that may be due to a poor coverage of data from 2001 to 2007. Within this context, it is remarkable, that we suppose a high degree of principal-agent problems for *Landesbanken* as reported in Table 13.

In contrast, savings banks owned by local communities provide the highest and statistically significant (standard beta) coefficient over the period 2008 to 2009. In this case, we clearly maintain our assumption that savings banks are showing a low relevance of principal-agent problems. Moreover, savings banks apparently prefer a counter-cyclical behavior while other banking sectors are increasing their asset side of the balance sheets (for further details on risk-taking behavior of German savings banks see for instance Holl and Schertler [2009] or Schmielewski [2012]).

Quite the opposite, banks monitored by dispersed shareholders generally appear to show a higher risk appetite than other banks since they obtain the lowest and statistically significant standard beta coefficients during the observation period. Although banks held by dispersed shareholders tend to increase their distances-to-default, they consistently enter the regressions with negative and statistically significant standard beta coefficients. This observation offers strong support for our hypothesis that those banks with dispersed and low concentrated shareholders are operating their business less risk averse than other German banking sectors due to the high relevance of principal-agent problems listed in Table 13.

These high-risk taking attitudes are comparable to those of banks owned by commercial banks because they also enter our regressions with negative and statistically significant coefficients throughout the observation period. *Commercial banks* evidently accepted low distances-to-default from 2001 to 2007 as well as during the episode of the mortgage subprime crisis from 2008 to 2009, when the financial crisis reached its melting point with the

default of Lehman Brothers and the disturbances of other globally operating bank holdings. This coincides with our assumption of medium principal-agent problems of *commercial banks* reported in Table 13.

In contrast, banks with a remarkable low risk appetite controlled by insurance companies and private banks appear to adjust their distances-to-default efficiently. This risk attitude relates to positive and statistically high significant coefficients over the observation period particularly in the case of banks allied to insurance companies. Thus, these results also provide strong support for our thesis that banks with low relevance of principal-agent problems are selecting their optimal portfolio efficiently as long as bank owners are carrying out considerable monitoring capabilities. Comparing private banks and subsidiaries of insurance companies demonstrate that standard beta coefficients of private banks are lower than those for banks held by insurance companies do. In summarizing, we can clarify that due to a low relevance of principal-agent problems private banks appear to be more risk averse than banks with differing ownership structures such as banks reporting dispersed shareholders or affiliates of commercial banks.

Finally, banks dominated by International bank holdings also enter our regression models with negative standard beta coefficients. Although these coefficients are statistically significantly from 2001 to 2007, we find only weak support for our hypothesis that banks affiliated with International bank holdings emerge a higher risk appetite in the course of the financial crisis from 2008 to 2009 than other banks. Quite the opposite, contrary to the findings for the period 2001 to 2007 the standard beta coefficients of our regression model for the period of 2008 to 2009 are relatively low and not statistically significant that may be due to the moderate relevance of principal-agent problems listed in Table 13.

Lastly, the *market share* of banks negatively relates to the distance-of-default since it obtains a negative and statistically significant coefficient for the period 2001 to 2009. These findings are consistent with some research papers showing that the market share of a bank positively correlates to its risk-taking behavior (Boyd and De Nicolo [2005], Laeven and Levine [2009]). In the case of our dummy variable reflecting *exchange traded* banks, our regression models display a coefficient that is not statistically significant for the period 2001 to 2007 while it seems more likely that exchange traded banks are tied to lower distances-to-default than banks not listed on a stock exchange from 2008 to 2009.

Table 13: Assessment of German banking sectors
This table displays our assessment of German banking sectors in accordance to profit pressure, degree of incentive compensation, and monitoring capabilities of principals (DD='distance-to-default', FSA='federal state authorities', LC='local communities, σ (ROA)=sector specific standard deviation of return on assets).

Principal	Averaged DD (2001-2007)	DD 2008	σ (ROA)	Relevance of Principal-Agents Problems
Private	12.81	8.26	0.0054	Low
International bank holdings	6.38	6.70	0.0116	Medium
Dispersed shareholders	3.60	2.97	0.0274	High
FSA (Landesbanken)	6.11	3.45	0.0040	High
Commercial bank	4.59	3.02	0.0114	Medium
Insurance company*	15.43	15.17	0.0029	Medium
Federal state authorities	24.90	9.23	0.0089	Low
LC (savings banks)	8.13	8.65	0.0064	Low to medium
Members of cooperatives	5.35	5.77	0.0100	Low
Cooperatives	13.68	17.00	0.0026	Low

*law permits only low risk bearing assets (BaFin [2011])

Table 14: Ordinary least squares (OLS) regressions on percentiles of distances-to-default (DD)[13]
This table shows the standard beta coefficients of ordinary least squares (OLS) regressions over the period 2001 to 2007 and from 2008 to 2009. The dependent variable is the percentile of distances-to-default (DD). The sample covers 3,194 yearly observations from 397 banks (FSA='federal state authorities', LC='local communities). Significance levels are marked with *** (P>t) <=0.01, ** (P>t) <=0.02 and * (P>t) <=0.05.

	2001-2007			2008-2009		
	Coef.	Std. Err.	Beta	Coef.	Std. Err.	Beta
Market share	-0.036	0.0061	-0.107***	-0.013	0.0054	-0.074**
Exchange traded	-0.022	0.0263	-0.022	-0.113	0.0416	-0.118***
Member of cooperatives	-0.351	0.0296	-0.473***	-0.152	0.0438	-0.202***
FSA (Landesbanken)	-0.061	0.0667	-0.017	-0.164	0.0641	-0.093**
Local communities (savings banks)	-0.010	0.0281	-0.017	0.175	0.0411	0.300***
Dispersed shareholders	-0.454	0.0361	-0.340***	-0.253	0.0550	-0.202***
Commercial bank	-0.356	0.0385	-0.227***	-0.249	0.0572	-0.174***
Cooperatives	0.105	0.0476	0.044*	0.416	0.0749	0.184***
Insurance companies	0.284	0.0544	0.105***	0.526	0.0936	0.178***
International bank holdings	-0.282	0.0394	-0.250***	-0.012	0.0628	-0.010
Private	0.201	0.0397	0.115***	0.137	0.0612	0.081*
Intercept	0.624	0.0274		0.464	0.0395	
r-squared	0.4214			0.4457		
Adj.r-squared	0.4184			0.4369		

To conclude this section, we are able to ascertain that ownership structures of banks display a statistically significant relationship with our considered measurement of distances-to-default. Furthermore, the results confirm our assumptions on the relevancy of principal-agent problems to a high degree.

[13] All regressions are examined by the means of STATA 11.0 with default standard errors

Conclusions

In a first stage, we rely on a theoretical model explaining that from the bank owners' viewpoint three factors of the principal-agent relationship are determining the probability of finding the optimal portfolio of risky assets such that are the ability to control bank managers, risk pooling by bank owners and bank managers, and incentives of seeking high returns.

Depending on the relevance of the emerging principal-agent problems, the ownership structure of a bank may mislead the bank manager's risk-taking behavior in such a way that she chooses an unreasonable position of risky assets that result in bank owner's disutility.

Moreover, it seems likely that the greater the profit pressure on bank managers exerted by bank owners to seek high returns the greater the probability that bank managers take excessive risky positions. Furthermore, it is intuitive that the lower the monitoring capabilities of bank owners the greater the probability of failures in choosing the optimal portfolio of risky assets from the bank owners' viewpoint. These assumptions are of major interest to the bank owners since the marginal increase of return is the lower the higher the level of risk as suggested by Markowitz (1952).

In a second stage, by comparing different kinds of ownership structures within the German banking industry we offer empirical evidence that the risk-taking attitudes of bank managers are depending on the ability to control bank managers, the risk pooling by bank owners and bank managers, and the incentives of seeking high returns. In detail, we can underline the distinguishable risk-taking behavior of bank managers that are participating different principal-ownership-structures by measuring the according distances-to-default reported for the period from 2000 to 2010.

Finally, we tend to argue that our theoretical model as well as our empirical findings could explain the ambiguous results in recent literature. Particularly, our theoretical model may contribute to the current discussions with regulatory authorities on necessary changes of the supervisory framework: If 'private banks are the better banks' due to a lower emergence of principal-agent problems these banks might be regulated to a lower degree. By contrast, legislative and regulatory authorities should increase their vigilance in terms of principal-agent problems within certain sectors of the banking industry demonstrating a high relevance of principal-agent problems.

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